SHALLOW-WATER PERFORMANCE OF A PLANING BOAT

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25 April 1969

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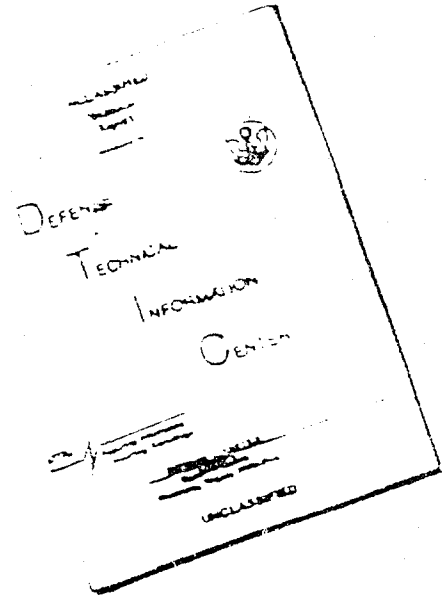

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Andras Istvan Toro

THE DEPARTMENT OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

[redacted]

COLLEGE OF [redacted]

SHALLOW-WATER PERFORMANCE OF A PLANING BOAT

by

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Southeast Section of SNAME
April 25, 1969

ABSTRACT

The results of a planing-boat model resistance test program conducted at four different water depths, including deep water, and three locations of LCG are presented. The sensitivity of the resistance of a planing boat to shallow water through the critical speed range (F_{nh} = 0.5-3.5) is analyzed and compared with the deep-water results. Near the critical speed (subplaning), horsepower increases dramatically due to shallowness, but at planing speeds the power is reduced. The paper also gives extrapolated results for a boat of 100,000 lb gross weight. Model and full-scale results are presented in convenient graphical and tabular form for further use.

INTRODUCTION

At the present time, very limited test results which enable a planing-boat designer to approximate resistance in shallow water are available. Several systematic series and the planing-prism data give powering estimates only for deep-water application. Shallow-water data is available only for displacement hulls. However, the resistance of a planing hull in shallow water can be significantly different than in deep water. The greatest effect of shallowness on trim, CG rise, and resistance is at relatively low F_∇ or speeds somewhat less than hump speeds, which is the general operating condition where trim, CG rise, and resistance are the most sensitive to speed changes. This is important even for a boat designed to normally operate at relatively high F_∇ and in deep water, since the low speeds such a boat would experience would be in channels, rivers, and harbors where the water is shallow.

The need for shallow-water data and the opportunity to investigate an interesting phenomenon led to tests of a Series 62 hull form in four different water depths and at three different LCG locations. The tests were performed at The University of Michigan Ship Hydrodynamics Laboratory in Ann Arbor, Michigan.

NOMENCLATURE*

A_p	=	Projected planing-bottom area, excluding area of external spray strip, sq ft
B_p	=	Beam or breadth over chines, exluding external spray strip, ft
B_{PA}	=	Mean Breadth over chines: A_p/L_p, ft
B_{PT}	=	Breadth over chines at transom, excluding external spray strip, ft
B_{PX}	=	Maximum breadth over chines, exluding external spray strip, ft
BL	=	Base line
b	=	Breadth over spray strips at longitudinal location of center of gravity, ft
CL	=	Centerline
CG	=	Center of gravity
C_T	=	Total resistance coefficient
C_R	=	Residual resistance coefficient
h	=	Finite depth of water, ft
F_n	=	Froude number based on length

*Nomenclature used is ITTC Standard Symbols and that recommended in SNAME T & R Bulletin 1-23.

F_{nh}	=	Froude number based on finite depth
F_V	=	Froude number based on volume
g	=	Acceleration of gravity, ft/sec^2
L_{AV}	=	Average wetted length, ft
LCG	=	Longitudinal center of gravity
L_P	=	Projected chine length, ft
L/D	=	Lift-drag ratio
P_E	=	Effective horsepower
R_{TM}	=	Total Model resistance, lb
R_{TS}	=	Total full-scale resistance, lb
R_R/Δ	=	Residual resistance-weight ratio
R_{TS}/Δ	=	Total full-scale resistance-weight ratio
$R_{Rh}/R_{R\infty}$	=	Shallow-water residual resistance-deep-water residual resistance ratio
$RISE/\nabla^{1/3}$	=	CG rise coefficient
S	=	Wetted surface, sq ft
$S/\nabla^{2/3}$	=	Wetted surface coefficient
v_W	=	Velocity of wave propagation, ft/sec
V_K	=	Velocity of ship, knots

V_M	=	Velocity of model, ft/sec
$V/\sqrt{L}$	=	Speed-length ratio
α	=	Angle of attack at after portion of planing bottom, degrees
λ	=	scale ratio, model to ship
λ_W	=	Wavelength, ft
β	=	Deadrise angle of planing bottom, degrees
ρ	=	Mass density of water
ν	=	Kinematic viscocity
∇	=	Volumetric displacement at rest, cu ft
$\nabla/A_p h$	=	Mean draft-water depth ratio

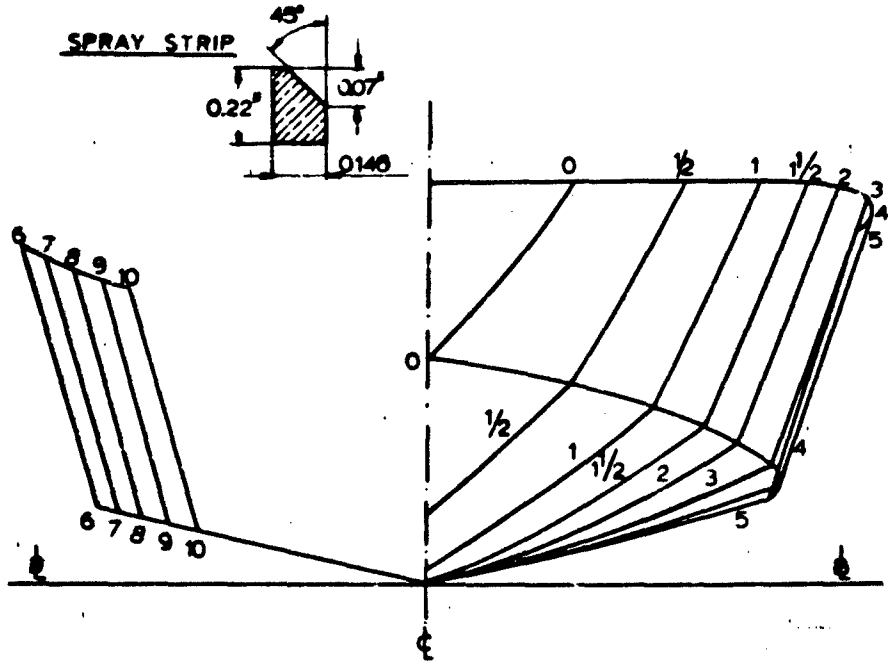
DESCRIPTION AND SCOPE OF THE TESTS

As mentioned previously, a Series 62 hull form (L_P/B_{PX} = 3.06) was selected (see Figure 1), as a representative planing hull form.

Particulars of the Model No. 1174

A_P, ft	= 3.322	B_{PX}/B_P	= 1.21
L_P, ft	= 3.50	B_{PT}/B_{PX}	= 0.71
B_{PA}, ft	= 0.949	Centroid of A_P, %	
B_{PX}, ft	= 1.144	L_P Forward of Transom	= 48.2
B_{PT}, ft	= 0.810		
L_P/B_{PA}	= 3.69		
L_P/B_{PX}	= 3.06		

The model was made of wood (sugar pine) and plastic spray strips were fitted on the hull as described in Reference [1], for details see Figure 1. The surface of the model was varnished, and for stimulating turbulent flow, a trip wire 0.035 inches in diameter was fitted on each side of the stem as described in Reference [1], also see Figure 1 for details. On the outside surface of the model, every station and half-station were marked for reading the solid-water wetted length and for obtaining wetted surface.



MODEL Nº 1174

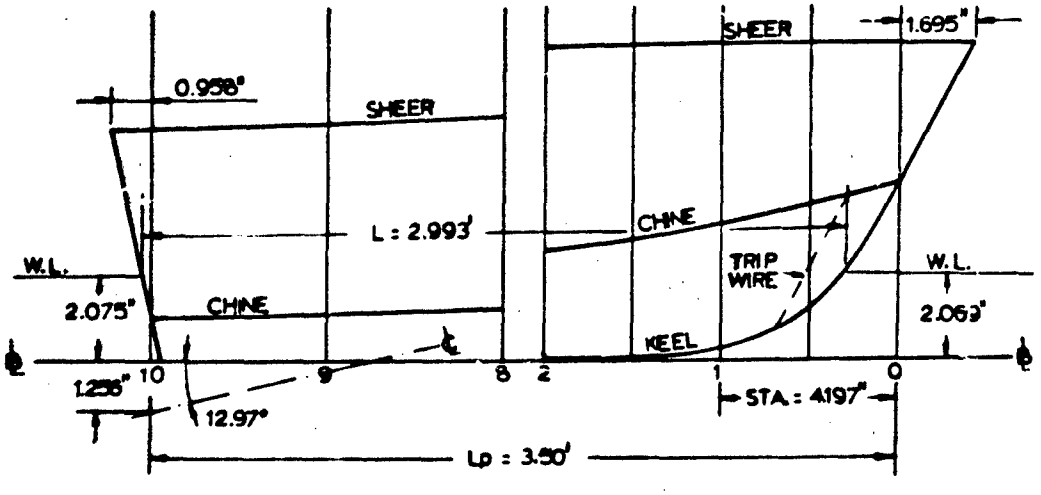


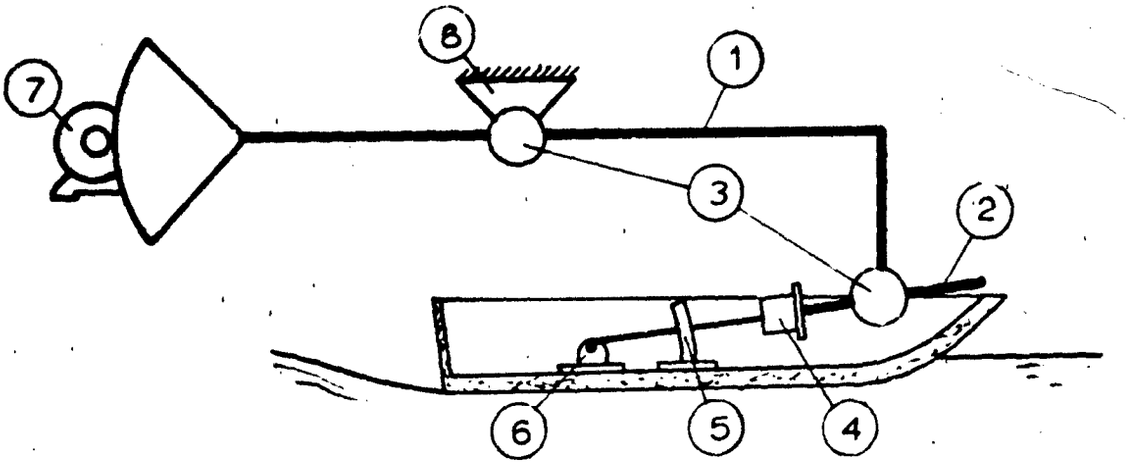
FIGURE 1

A new multilever testing apparatus (Figure 2) was used to measure the towing force on the propeller shaft centerline. The apparatus automatically adjusted by a servo-system to coincide with the shaft line during each run. A switch was attached in the bottom of the model and set for the correct shaft inclination in the static condition. This was the neutral position of the switch, at which time no current was flowing. The tow rod acted as the sliding part of the switch. Whenever the hull trimmed up or down to a new running position, the switch moved out of its neutral position, thereby completing the servo-motor curcuit. The purpose of the motor was to drive the pivoting upper frame to the correct shaft position, at which time the servo-switch became neutral again.

Sinkage and trim were recorded from the same apparatus. For determining wetted surface and wetted length, photographs were taken (see Appendix).

The location of the longitudinal CG is defined as the distance of the LCG from the centroid of the area A_p, expressed as a percentage of the length L_p. For the tests, 2%, 6%, and 10% were used.

The shallow-water depths were chosen to be 7.5, 12.0, and 20.0 inches model scale. In order to relate the shallow-water depth (h) to the boat geometry, a new nondimensional



MULTI-LEVER TESTING APPARATUS

1. Pivoting upper frame.
2. Rotating lower frame.
3. Angle measuring pots.
4. Force measuring device.
5. Servo-switch.
6. Tow point.
7. Servo-motor.
8. Fix attachment to carriage.

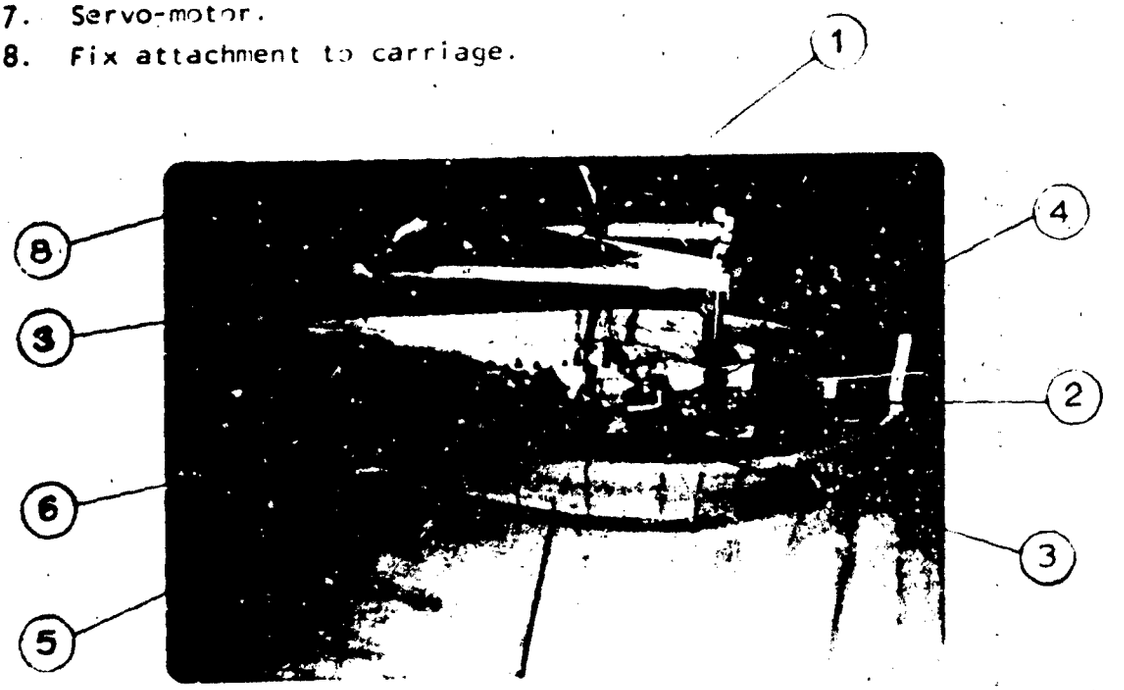


FIGURE 2

parameter is used, $\nabla/A_p h$. The mean draft-water depth parameter is independent of LCG position. The values of $\nabla/A_p h$ were 0.157, 0.098, and 0.059, respectively, for decreasing water depth.

The length of the adjustable shallow-water bottom in the model basin is 90 feet. Variation of the bottom was ±1/8 inch. There was considered to be no leakage since the bottom was newly installed and made of rigid fiberglass panels.

TEST RESULTS

Tabulated model results for all the tests are given in the Appendix. The resistance data for all conditions have been expanded to a boat gross weight of 100,000 lb. This weight represents a somewhat large-sized motor yacht with a length of approximately 60 feet. The ATTC friction coefficients were used with zero correlation allowance.

Figures 3, 4, and 5 compare model values of resistance, trim, and CG rise at four water depths with each at the same LCG location. The effect of shallowness is evident by simple observation.

Considering the shallow-water phenomenon in more detail for a boat moving in water of restricted depth but unrestricted width at $F_{nh} \approx 1.0$, the water passing under the hull must speed up more than in deep water, which causes reduction in the pressure gradient and an increase in resistance with greater sinkage and trim. The shallower the water depth, the more pronounced is the effect.

The case with the least clearance under the transom was at the 10% LCG location and in 7.5 inches of water. At the critical speed (near $F_{nh} = 1.0$) the clearance was approximately 4.0 inches under the transom. In these conditions the water will not flow underneath the hull as easily as in deep water. The flow goes around the hull and sets up a different wave pattern, which is the other important shallow-water phenomenon. As explained in Reference [2], on page 320, the wave pattern follows the law of dispersion of gravity waves.

The velocity of surface waves is given by

$$v_w^2 = \left(\frac{g\lambda_w}{2\pi}\right) \tanh \frac{2\pi h}{\lambda_w} \quad . \qquad (1)$$

For shallow water (h small),

$$\tanh \frac{2\pi h}{\lambda_w} = \frac{2\pi h}{\lambda_w} \qquad (2)$$

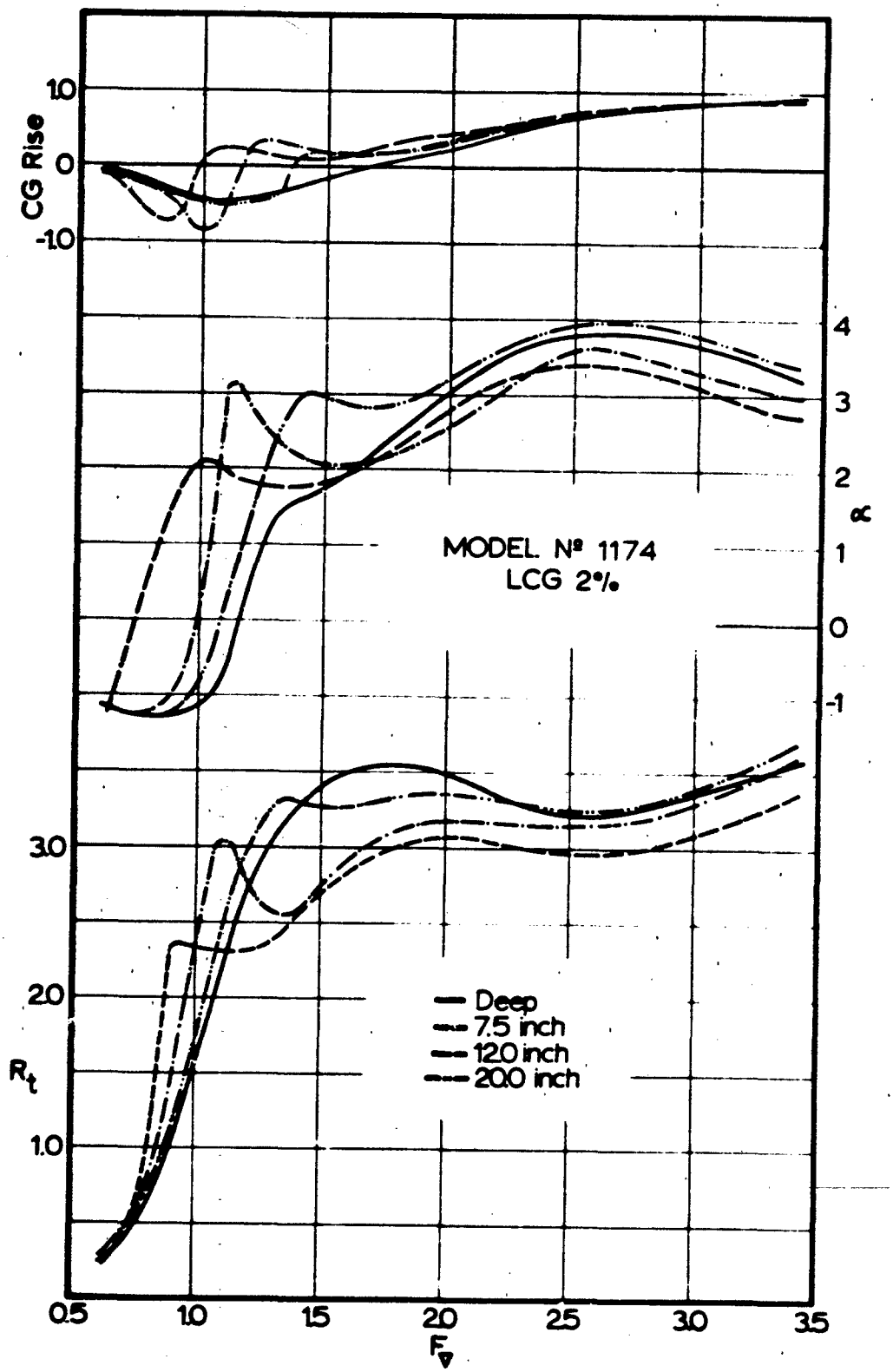

CG Rise
10
0
-10
4
3
2
α
1
0
-1
MODEL Nº 1174
LCG 2%
3.0
2.0
R_t
1.0
— Deep
— 7.5 inch
— 12.0 inch
— 20.0 inch
0.5
1.0
1.5
2.0
2.5
3.0
3.5
F_∇

Figure 3

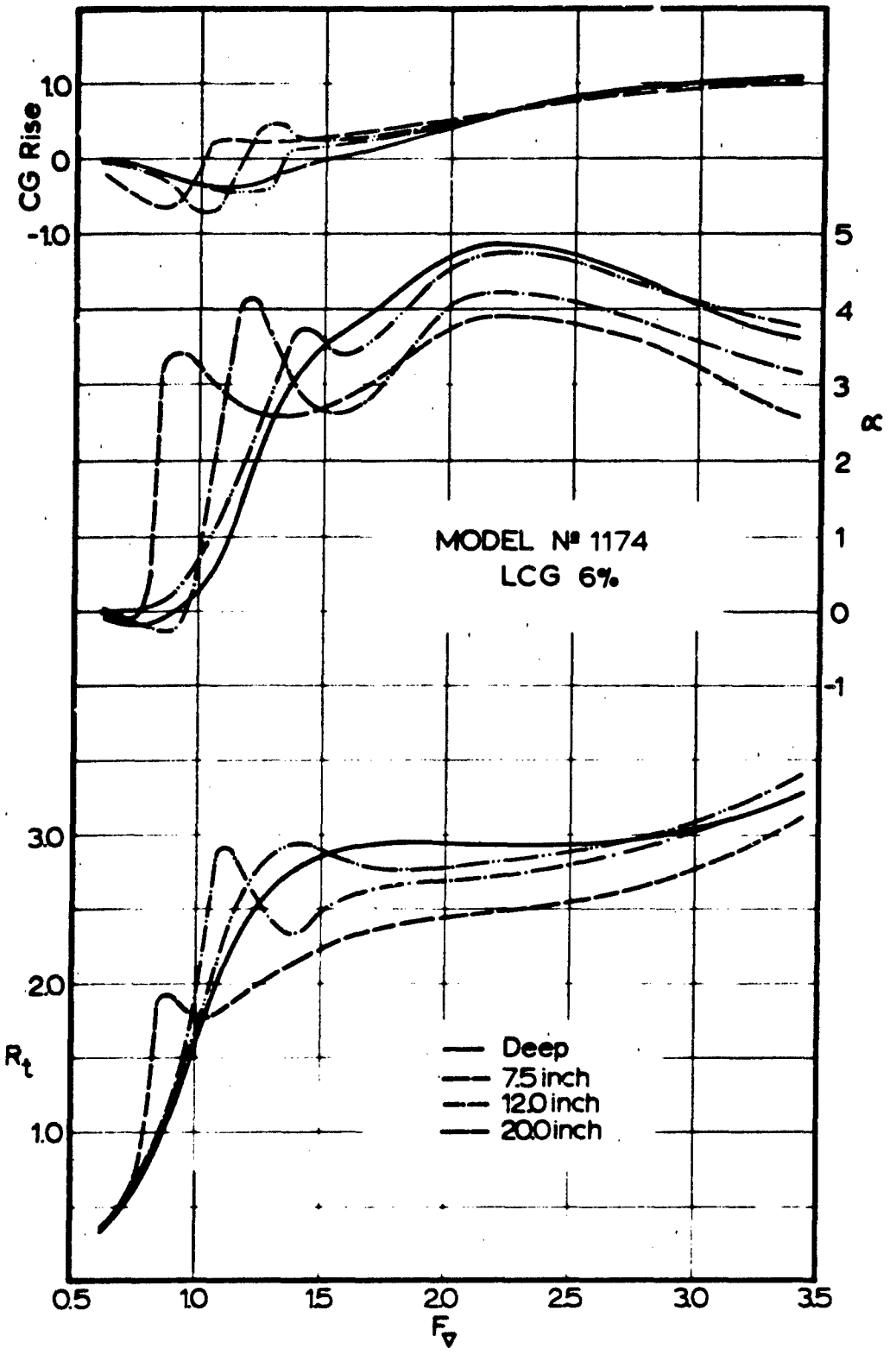

CG Rise
1.0
0
-1.0
5
4
3
α
2
1
0
-1
MODEL Nº 1174
LCG 6%
3.0
2.0
R_t
1.0
Deep
7.5 inch
12.0 inch
20.0 inch
0.5
1.0
1.5
2.0
2.5
3.0
3.5
F_∇

Figure 4

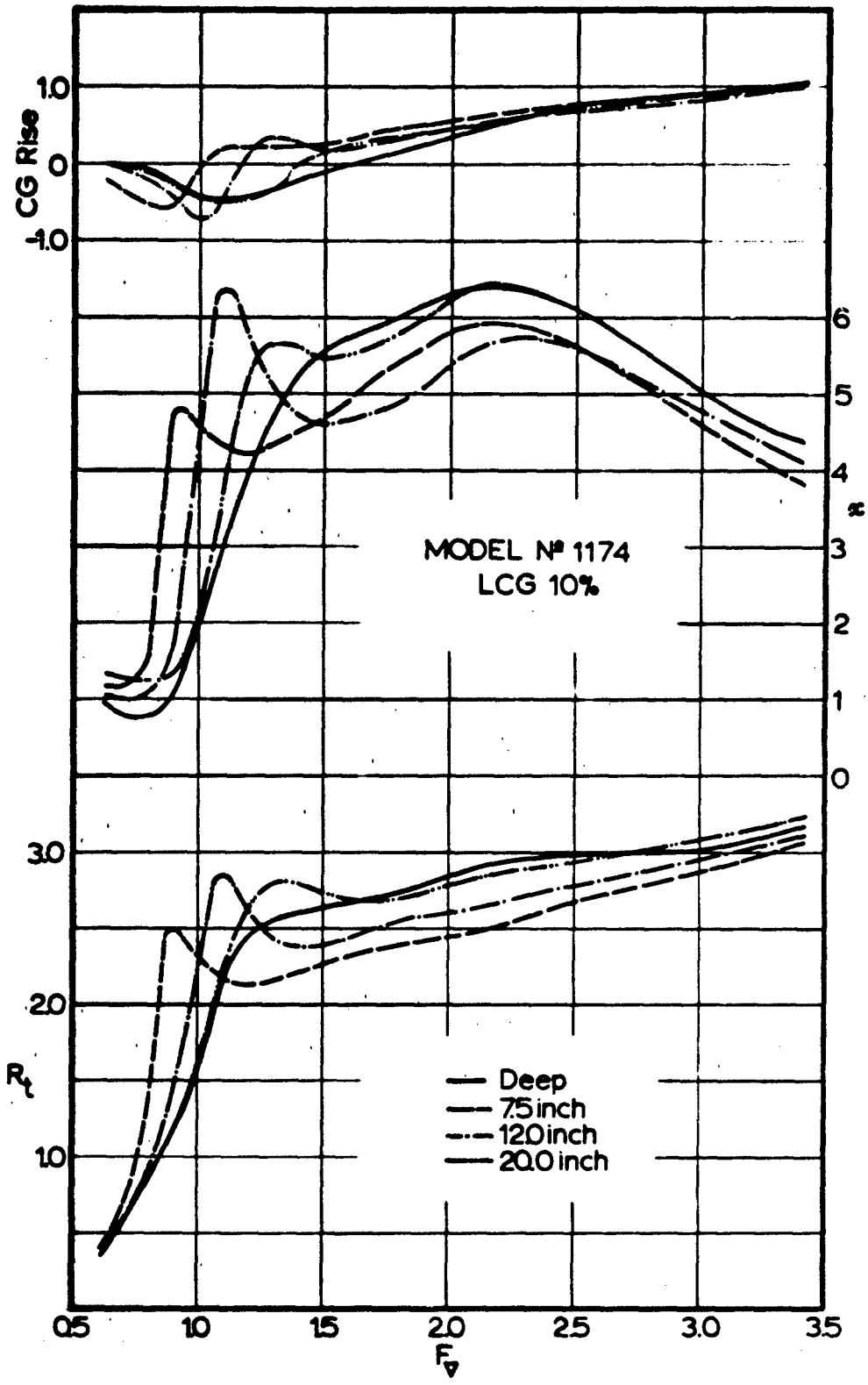

CG Rise
1.0
0
-1.0
6
5
4
3
2
1
0
α
MODEL Nº 1174
LCG 10%
3.0
2.0
1.0
R_t
Deep
7.5 inch
12.0 inch
20.0 inch
0.5
1.0
1.5
2.0
2.5
3.0
3.5
F_∇

Figure 5

and

$$v_w = \sqrt{gh} \qquad (3)$$

or

$$F_{nh} = 1.0 \quad . \qquad (4)$$

This means that for $F_{nh} = 1.0$ the free waves generated by the boat travel with it and appear to form abreast of the boat. That is, the usual Kelvin angle is nearly 19°. At lower speeds (subcritical) the waves are oriented in the usual manner with an angle of 90° 28'. At higher speeds (supercritical) the waves tend to reorient themselves to angles less than 90°, depending on speed. These different wave formations may be expected to represent wave energy losses different than in shallow water, hence alterations in wave resistance. The critical speed is when the residual resistance is greatest (Figure 6).

Because of the trim-sensitive nature of planing boats, and their proportionality between angle of attack and induced drag, one can see how shallowness causes sudden increases in resistance and sinkage. The trend of the shape of all curves is to slowly converge to that of the deep-water condition as $\nabla/A_p h \to 0$.

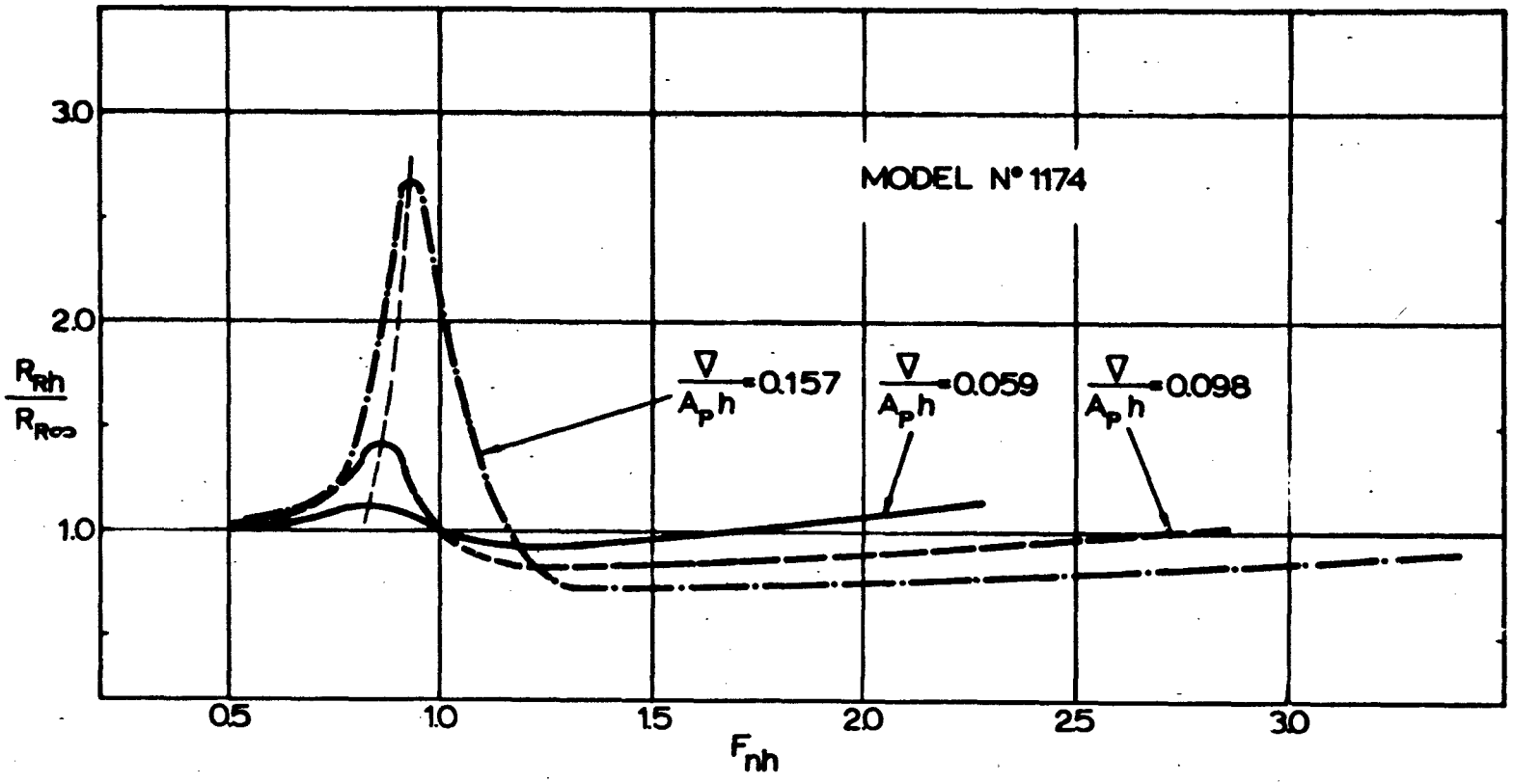

MODEL N° 1174
3.0
2.0
1.0
$\frac{R_{Rh}}{R_{Ro\infty}}$
$\frac{\nabla}{A_p h}$=0.157
$\frac{\nabla}{A_p h}$=0.059
$\frac{\nabla}{A_p h}$=0.098
0.5
1.0
1.5
2.0
2.5
3.0
F_{nh}

Figure 6

It is interesting to note that the curves in Figure 6 for each value of $\nabla/A_p h$ are drawn through the data for all LCG's, there being little variation due to LCG, even though one might anticipate otherwise from the previous reasoning. However, for each curve both the R_{Rh} and $R_{R\infty}$ on the ordinate scale in Figure 6 are taken for the same LCG. Therefore, the change in angle of attack is not influenced by LCG position for a given shallow-water depth.

On Figure 6, in the supercritical region the curves drop below $R_{Rh}/R_{R\infty} = 1$, representing a power savings. Indeed, that phenomenon is also governed primarily by F_{nh} and secondarily by $\nabla/A_p h$. In this supercritical domain, the local flow contributes to greater dynamic lift, which is also shown by the sinkage curves. Eventually all curves in Figure 6 go above $R_{Rh}/R_{R\infty} = 1$ at high F_{nh}, at which time the adverse wave formations again become dominant.

Presentation of power curves was necessary for practical application. In Figures 7 and 8, P_E (effective horsepower) is plotted against V_K (speed in knots), holding the water depth constant and showing the power variation with LCG locations. In shallow water the optimum LCG position does not seem to vary significantly from

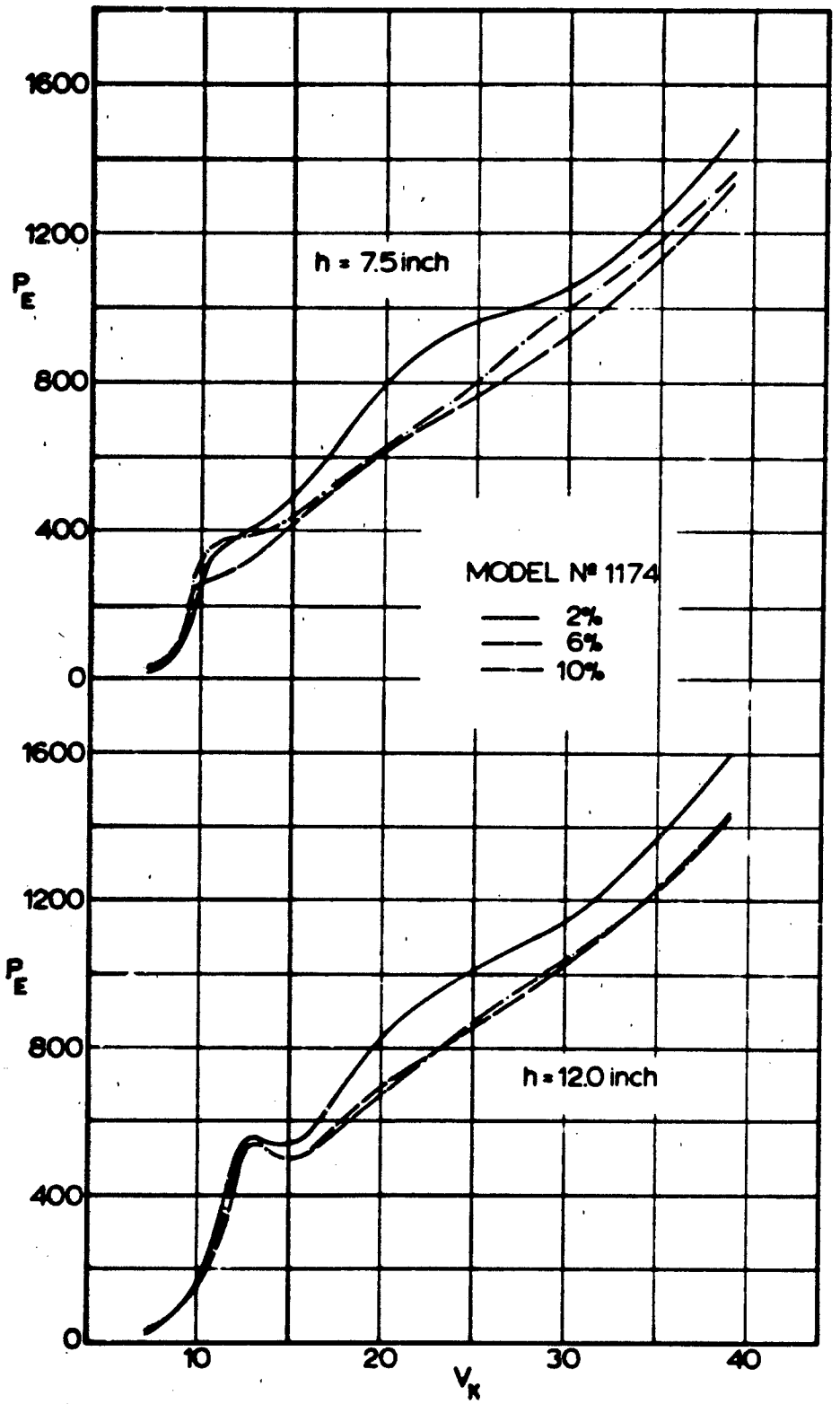

1600
1200
800
400
0
P_E
h = 7.5 inch
MODEL Nº 1174
2%
6%
10%
1600
1200
800
400
0
P_E
h = 12.0 inch
10
20
30
40
V_K

Figure 7

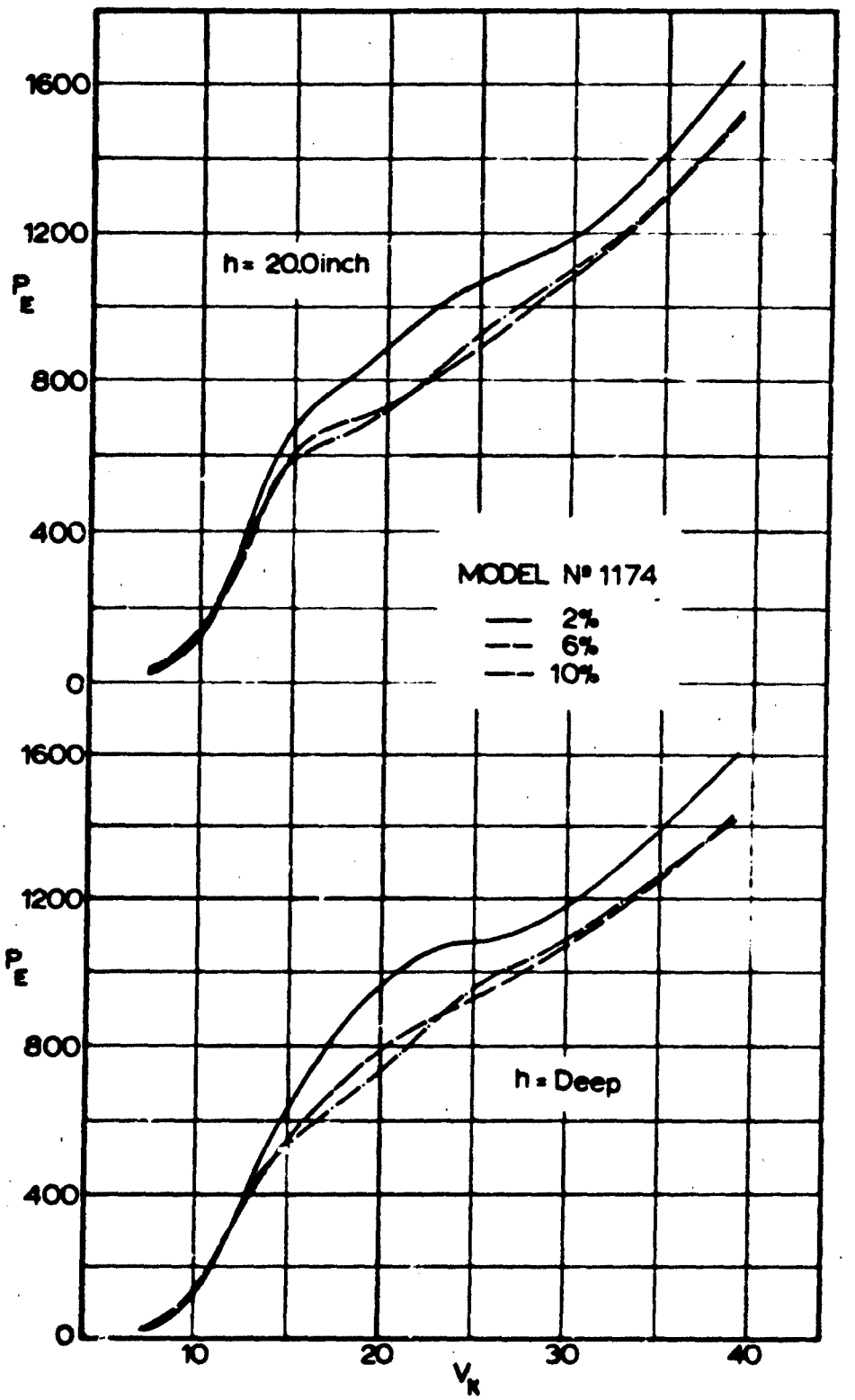

1600
1200
800
400
0
P_E
h= 20.0inch
MODEL Nº 1174
2%
6%
10%
1600
1200
800
400
0
P_E
h = Deep
10
20
30
40
V_K

Figure 8

what the deep-water results show. At critical speeds, power may be increased by a factor of two or more, while at supercritical speeds power reductions of 10%-15% may be anticipated.

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2. Principles of Naval Architecture, Edited by J. P. Comstock, Published by SNAME, 1967.

3. "Systematishe Untersuchungen von Kleinschiffsformen auf flachem Wasser im unter- und überuritishen Geschwindigkeitsbereich," No. 617, by Prof. Dipl.-Ing. Wilhelm Sturtzel und Dr.-Ing. Werner Graff, Forschungsberichte des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen.

4. Class notes from NA 401: "Small Craft Design," Taught by J. L. Moss, and NA 42 0: "Resistance, Propulsion, and Propellers," Taught by Dr. S. D. Sharma, The University of Michigan, College of Engineering, Department of Naval Architecture and Marine Engineering, Winter Term 1969.

APPENDIX

MODEL NO. : 1174 L.C.G. LOCATION : 28 TEMPERATURE : 68.0°F SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 2-00 MODEL LENGTH : 3.50 ft ρ : 1.9364 ROUGHNESS ALLOWANCE : 0.0000

DATE : 15 February 1969 SCALE RATIO : 16.84 μ : 0.10808×10^{-4} FRICTION LINE : A.T.T.C.

WATER DEPTH = DEEP

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{V^{\frac{2}{3}}}$	$\frac{RISE}{V^{\frac{1}{3}}}$	$\frac{L}{D}$	F_V	F_{nh}
3.00	.254	-1.13	-.05	3.40	3.45	7.29	0.945	0.282	927.7	8.573	4.127	0.009	0.006	20.8	7.161	-0.006	107.79	0.637	
3.50	.450	-1.23	-.15	3.53	3.52	8.50	1.107	0.329	1776.5	0.107	6.448	0.018	0.013	46.4	7.434	-0.018	56.29	0.743	
4.00	.802	-1.28	-.27	3.62	3.64	9.71	1.266	0.377	3380.2	0.143	0.101	0.034	0.028	100.9	7.624	-0.033	29.58	0.849	
4.50	1.292	-1.23	-.40	3.64	3.64	10.93	1.426	0.424	5653.2	0.181	0.140	0.057	0.049	189.8	7.666	-0.048	17.69	0.955	
5.00	1.915	- .88	-.45	3.56	3.53	12.14	1.582	0.471	8582.4	0.222	0.182	0.086	0.077	320.1	7.498	-0.054	11.65	1.062	
5.50	2.515	0.17	-.42	3.52	3.45	13.36	1.740	0.518	11384.0	0.243	0.204	0.114	0.103	467.1	7.413	-0.051	8.78	1.168	
6.00	2.937	1.27	-.35	3.45	3.40	14.57	1.898	0.565	13314.2	0.244	0.205	0.133	0.121	595.9	7.27	-0.042	7.51	1.274	
6.50	3.175	1.57	-.23	3.37	3.33	15.79	2.057	0.612	14318.2	0.230	0.191	0.143	0.130	695.2	7.10	-0.028	6.97	1.380	
7.00	3.356	1.72	-.14	3.30	3.25	17.00	2.215	0.660	15073.6	0.214	0.176	0.151	0.135	787.1	6.95	-0.017	6.63	1.486	
7.50	3.508	1.92	-.06	3.22	3.15	18.22	2.373	0.706	15665.0	0.200	0.161	0.157	0.139	876.4	6.78	-0.007	6.38	1.592	
8.00	3.551	2.27	.00	3.13	3.05	19.43	2.532	0.754	15723.9	0.183	0.145	0.157	0.138	938.3	6.59	0.0	6.36	1.699	
8.50	3.555	2.52	+.07	3.00	2.95	20.65	2.690	0.801	15614.9	0.169	0.131	0.156	0.136	990.1	6.32	0.008	6.40	1.805	
9.00	3.53.	2.77	+.17	2.91	2.80	21.86	2.848	0.848	15348.6	0.154	0.117	0.154	0.131	1030.4	6.13	0.020	6.52	1.911	
9.50	3.489	3.02	+.28	2.82	2.70	23.08	3.006	0.895	14982.2	0.121	0.104	0.150	0.126	1061.7	5.94	0.034	6.67	2.017	
10.00	3.418	3.27	+.38	2.74	2.62	24.29	3.165	0.942	14480.5	0.128	9.144	0.145	0.119	1080.2	5.77	0.046	6.91	2.123	
11.00	3.258	3.67	+.57	2.60	2.47	26.72	3.481	1.036	13376.3	0.107	6.981	0.134	0.104	1097.6	5.48	0.069	7.48	2.336	
12.00	3.226	3.82	+.70	2.49	2.38	29.15	3.797	1.130	12897.0	9.292	5.610	0.129	0.096	1153.6	5.24	0.085	7.76	2.4[illegible]	
13.00	3.254	3.82	+.77	2.32	2.28	31.58	4.114	1.225	12775.7	8.572	4.912	0.128	0.092	1238.9	4.89	0.092	7.83	2.761	
14.00	3.354	3.67	+.85	2.26	2.20	34.01	4.431	1.319	12882.8	7.820	4.187	0.129	0.088	1345.4	4.76	0.103	7.76	2.973	
15.00	3.453	3.47	+.90	2.15	2.12	36.44	4.747	1.413	13066.9	7.372	3.760	0.131	0.087	1462.1	4.53	0.109	7.65	3.185	
16.00	3.553	3.22	+.97	2.04	2.03	38.87	5.064	1.507	13268.7	7.027	3.428	0.133	0.085	1583.6	4.30	0.117	7.54	3.3[illegible]	

Model No. : 1174 | L.C.G. LOCATION : 28 | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 2-75 | MODEL LENGTH : 3.50 ft | ρ : 1.9366 | ROUGHNESS allowance : 0.0000

DATE : 15 Feb. 1969 | SCALE RATIO : 16.84 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = 7.5 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{\text{RISE}}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_v	F_{nh}
3.00	.215	-1.18	-.15	3.50	3.55	7.29	0.945	0.282	729.1	7.05	2.63	0.007	0.003	16.3	7.37	-0.018	137.10	0.637	.660
3.50	.526	-.03	-.52	3.64	3.64	8.50	1.107	0.329	2139.7	0.122	7.91	0.021	0.017	55.9	7.66	-0.063	46.76	0.743	.780
4.00	1.551	1.17	-.70	3.62	3.55	9.71	1.266	0.377	7053.7	0.277	0.235	0.071	0.065	210.5	7.62	-0.085	14.18	0.839	.891
4.50	2.367	1.97	-.25	3.56	3.45	10.93	1.421	0.424	10936.8	0.339	0.298	0.109	0.102	367.1	7.49	-0.030	9.14	0.955	1.003
5.00	2.318	2.02	+.21	3.50	3.34	12.14	1.582	0.471	10564.5	0.273	0.233	0.106	0.097	394.0	7.37	0.025	9.47	1.062	1.114
5.50	2.300	1.87	+.21	3.43	3.25	13.36	1.740	0.518	10340.1	0.228	0.188	0.103	0.093	424.2	7.22	0.025	9.67	1.168	1.226
6.00	2.368	7.82	+.16	3.35	3.17	14.57	1.898	0.565	10535.5	0.202	0.163	0.105	0.094	471.5	7.05	0.019	9.49	1.274	1.337
6.50	2.515	1.77	+.12	3.27	3.10	15.79	2.057	0.612	11115.2	0.188	0.148	0.111	0.097	538.9	6.88	0.015	9.00	1.380	1.448
7.00	2.658	1.82	+.12	3.18	3.03	17.00	2.215	0.660	11676.1	0.176	0.137	0.117	0.102	609.7	6.69	0.015	8.56	1.486	1.560
7.50	2.802	1.97	+.17	3.10	2.96	18.22	2.373	0.706	12235.7	0.166	0.127	0.122	0.105	684.5	6.52	0.020	8.17	1.592	1.671
8.00	2.935	2.12	+.27	3.04	2.90	19.43	2.532	0.754	12729.8	0.155	0.117	0.127	0.109	759.7	6.40	0.033	7.86	1.699	1.783
8.50	3.028	2.37	+.35	2.96	2.85	20.65	2.690	0.801	13038.1	0.146	0.108	0.130	0.110	826.7	6.23	0.042	7.67	1.805	1.894
9.00	3.053	2.62	+.40	2.90	2.78	21.86	2.848	0.848	12995.9	0.134	9.653	0.130	0.[illegible]	872.5	6.11	0.048	7.69	1.911	2.006
9.50	3.069	2.82	+.46	2.83	2.72	23.[illegible]	3.006	0.895	12916.5	0.124	8.662	0.129	0.105	915.3	5.96	0.056	7.74	2.017	2.117
10.00	3.057	3.07	+.53	2.76	2.65	24.[illegible]	3.165	0.942	12697.6	0.114	7.708	0.127	0.101	947.2	5.81	0.064	7.88	2.123	2.229
11.00	2.994	3.32	+.65	2.63	2.51	26.72	3.481	1.036	12059.8	9.717	6.013	0.121	0.091	989.5	5.54	0.079	8.29	2.336	2.452
12.00	2.965	3.37	+.75	2.50	2.40	29.15	3.797	1.130	11599.6	8.506	4.830	0.117	0.083	1038.3	5.27	0.090	8.62	2.548	2.675
13.00	2.994	3.32	+.83	2.36	2.28	31.58	4.111	1.225	11444.3	7.753	4.095	0.114	0.077	1109.8	4.97	0.100	8.74	2.761	2.897
14.00	3.074	3.17	+.87	2.25	2.18	34.01	4.431	1.319	11516.8	7.199	3.561	0.116	0.075	1202.7	4.74	0.105	8.68	2.973	3.120
15.00	3.204	2.87	+.90	2.13	2.07	36.44	4.747	1.413	11860.0	6.905	3.277	0.119	0.075	1327.0	4.49	0.109	8.43	3.185	3.343
16.00	3.340	2.72	+.92	2.00	2.00	38.87	5.064	1.507	12291.2	6.738	3.129	0.123	0.076	1467.0	4.21	0.111	8.14	3.398	3.566

MODEL NO. : 1174 | L.C.G. LOCATION : 2% | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 2-12 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.0000

DATE : 22 Feb. 1969 | SCALE RATIO : 16.84 | ν : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = 12.0 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{\text{RISE}}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.303	-1.13	-.13	3.45	3.52	7.29	0.945	0.282	1165.1	0.100	5.650	0.012	0.008	26.1	7.266	-0.016	85.03	0.637	0.528
3.50	.597	-1.23	-.22	3.60	3.62	8.50	1.107	0.329	2492.5	0.139	9.704	0.025	0.020	65.1	7.58	-0.027	40.12	0.743	.616
4.00	.978	-1.13	-.35	3.64	3.63	9.71	1.266	0.377	4240.7	0.173	0.131	0.042	0.037	126.5	7.67	-0.042	23.58	0.849	.704
4.50	1.952	- .53	-.77	3.60	3.53	10.93	1.424	0.424	8824.0	0.276	0.233	0.088	0.081	296.2	7.58	-0.093	11.33	0.955	.792
5.00	2.904	1.57	-.78	3.52	3.40	12.14	1.592	0.471	13439.9	0.340	0.300	0.134	0.126	501.3	7.41	-0.094	7.44	1.062	.880
5.50	2.96	3.07	+.06	3.45	3.30	13.36	1.740	0.518	13577.8	0.292	0.253	0.136	0.126	557.1	7.27	0.001	7.36	1.168	.968
6.00	2.620	2.57	+.36	3.36	3.21	14.57	1.898	0.565	11772.5	0.223	0.184	0.118	0.106	526.9	7.00	0.044	8.50	1.274	1.056
6.50	2.557	2.27	+.28	3.28	3.14	15.79	2.057	0.612	11321.2	0.190	0.151	0.113	0.10	548.9	6.91	0.033	8.03	1.380	1.144
7.00	2.723	2.07	+.20	3.22	3.08	17.00	2.215	0.660	11983.2	0.178	0.139	0.120	0.10	625.7	6.78	0.024	8.35	1.486	1.233
7.50	2.897	2.07	+.16	3.15	3.02	18.22	2.373	0.706	12684.7	0.168	0.130	0.127	0.110	709.7	6.63	0.019	7.88	1.592	1.320
8.00	3.012	2.17	+.18	3.08	2.92	19.43	2.532	0.754	13088.4	0.157	0.119	0.131	0.112	781.1	6.49	0.022	7.64	1.699	1.408
8.50	3.107	2.27	+.22	3.02	2.91	20.65	2.690	0.801	13397.7	0.147	0.109	0.134	0.113	849.5	6.36	0.027	7.46	1.805	1.496
9.00	3.163	2.37	+.30	2.96	2.85	21.86	2.848	0.848	13516.0	0.136	9.880	0.135	0.113	907.4	6.23	0.036	7.40	1.911	1.584
9.50	3.178	2.62	+.40	2.90	2.78	23.08	3.006	0.895	13409.3	0.125	8.807	0.134	0.110	950.2	6.11	0.048	7.46	2.017	1.672
10.00	3.184	2.82	+.49	2.84	2.74	24.29	3.165	0.942	13072.1	0.145	7.870	0.133	0.106	990.0	5.98	0.058	7.53	2.123	1.76
11.00	3.151	3.37	+.67	2.72	2.60	26.72	3.481	1.036	12791.3	9.907	6.220	0.128	0.097	1049.6	5.73	0.080	7.82	2.336	1.936
12.00	3.162	3.62	+.72	2.60	2.50	29.15	3.797	1.130	12476.6	8.723	5.073	0.125	0.090	1116.8	5.48	0.090	8.01	2.548	2.112
13.00	3.192	3.52	+.77	2.47	2.39	31.58	4.114	1.225	12300.6	7.898	7.271	0.123	0.085	1192.8	5.20	0.093	8.13	2.761	2.288
14.00	3.309	3.39	+.85	2.35	2.28	34.01	4.431	1.319	12549.0	7.420	3.810	0.126	0.083	1310.5	4.95	0.103	7.97	2.973	2.464
15.00	3.440	3.12	+.88	2.24	2.18	36.44	4.747	1.413	12865.8	7.049	3.455	0.129	0.083	1439.6	4.72	0.106	7.77	3.185	2.640
16.00	3.596	2.97	+.90	2.13	2.08	38.87	5.064	1.507	13319.4	6.811	3.228	0.133	0.084	1589.7	4.49	0.109	7.51	3.398	2.816

MODEL NO. : 1174 L.C.G. LOCATION : 2% TEMPERATURE : 68.0°F SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 2-20 MODEL LENGTH : 3.50 ft ρ : 1.9364 ROUGHNESS ALLOWANCE : 0.0000

DATE : 22 Feb. 1969 SCALE RATIO : 16.84 μ : 0.10808×10^{-4} FRICTION LINE : A.T.T.C.

WATER DEPTH = 20.0 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{RISE}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.293	-1.03	-.10	3.45	3.50	7.29	0.945	0.282	1115.6	9.746	5.312	0.011	0.008	25.0	7.27	-0.012	89.64	0.637	.409
3.50	.518	-1.23	-.17	3.60	3.58	8.50	1.107	0.329	2103.5	0.121	7.845	0.021	0.016	54.9	7.58	-0.020	47.54	0.743	.477
4.00	.832	-1.25	-.30	3.66	3.64	9.71	1.266	0.377	3521.3	0.146	0.105	0.035	0.029	105.1	7.71	-0.036	28.40	0.849	.545
4.50	1.467	-1.03	-.42	3.64	3.60	10.93	1.424	0.424	6510.5	0.205	0.164	0.065	0.058	218.5	7.67	-0.051	15.36	0.955	.613
5.00	2.146	-0.33	-.50	3.58	3.50	12.14	1.582	0.471	9710.6	0.247	0.207	0.097	0.088	362.2	7.54	-0.060	10.30	1.062	.682
5.50	2.766	.97	-.48	3.50	3.40	13.36	1.740	0.518	12618.4	0.269	0.250	0.126	0.116	517.7	7.37	-0.058	7.92	1.168	.750
6.00	3.137	2.17	-.42	3.41	3.30	14.57	1.898	0.565	14301.2	0.263	0.224	0.143	0.131	640.1	7.18	-0.051	6.99	1.274	.818
6.50	3.319	2.87	+.10	3.32	3.22	15.79	2.057	0.612	15054.0	0.240	0.205	0.151	0.137	729.9	6.99	0.012	6.64	1.380	.886
7.00	3.289	2.97	+.20	3.21	3.15	17.00	2.215	0.660	14773.1	0.216	0.177	0.148	0.133	771.4	6.76	0.024	6.77	1.486	.954
7.50	3.271	2.87	+.20	3.13	3.04	18.22	2.373	0.706	14532.7	0.191	0.153	0.145	0.129	813.0	6.59	0.024	6.88	1.592	1.023
8.00	3.290	2.82	+.19	3.04	2.93	19.43	2.532	0.754	14476.4	0.174	0.136	0.145	0.126	863.9	6.40	0.023	6.91	1.699	1.091
8.50	3.330	2.87	+.21	2.96	2.85	20.65	2.690	0.801	14520.6	0.160	0.122	0.145	0.125	920.7	6.23	0.025	6.89	1.805	1.159
9.00	3.364	3.07	+.25	2.90	2.76	21.86	2.848	0.848	14519.3	0.147	0.110	0.145	0.123	974.8	6.11	0.030	6.89	1.911	1.227
9.50	3.361	3.27	+.35	2.84	2.70	23.08	3.006	0.895	14285.4	0.132	0.946	0.143	0.118	1012.3	6.13	0.042	7.00	2.017	1.295
10.00	3.378	3.47	+.46	2.75	2.63	24.29	3.165	0.942	14081.4	0.125	8.800	0.141	0.115	1050.4	5.79	0.055	7.10	2.123	1.364
11.00	3.285	3.77	+.62	2.63	2.50	26.72	3.481	1.036	13485.9	0.106	6.954	0.135	0.105	1106.6	5.54	0.075	7.42	2.336	1.500
12.00	3.253	3.97	+.70	2.50	2.40	29.15	3.797	1.130	13013.3	9.333	5.656	0.130	0.097	1164.9	5.27	0.085	7.68	2.548	1.636
13.00	3.291	3.92	+.78	2.40	2.32	31.58	4.114	1.225	1286.0	8.380	4.734	0.129	0.091	1247.1	5.05	0.094	7.78	2.761	1.773
14.00	3.400	3.82	+.85	2.30	2.24	34.01	4.431	1.319	13059.9	7.790	4.168	0.131	0.089	1363.9	4.84	0.103	7.66	2.973	1.909
15.00	3.545	3.62	+.90	2.20	2.15	36.44	4.747	1.413	13440.7	7.397	3.793	0.134	0.089	1503.9	4.63	0.109	7.44	3.185	2.046
16.00	3.693	3.42	+.95	2.12	2.07	38.87	5.064	1.507	13811.2	7.028	3.442	0.138	0.089	1648.4	4.46	0.115	7.24	3.393	2.182

MODEL NO. : 1176 | L.C.G. LOCATION : 68 | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 6-68 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.0000

DATE : 22 Feb. 1969 | SCALE RATIO : 16.86 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = DEEP

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{\text{RISE}}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.34	-0.1	0	3.35	3.40	7.29	0.945	0.282	1353.4	0.116	7.188	0.014	0.010	30.3	7.06	0.0	73.88	0.637	
3.50	.623	-0.2	-.09	3.38	3.41	8.50	1.107	0.329	2641.0	0.155	0.112	0.026	0.022	69.0	7.12	-0.011	37.86	0.743	
4.00	.876	-0.1	-.17	3.49	3.45	9.71	1.266	0.377	3756.6	0.162	0.119	0.038	0.032	112.1	7.35	-0.020	26.62	0.849	
4.50	1.36	0.15	-.27	3.53	3.52	10.93	1.424	0.424	6002.5	0.196	0.155	0.060	0.053	201.5	7.43	-0.033	16.66	0.955	
5.00	1.897	0.6	-.35	3.52	3.55	12.14	1.582	0.471	8504.8	0.222	0.182	0.085	0.076	317.2	7.41	-0.042	11.76	1.062	
5.50	2.353	1.4	-.36	3.47	3.52	13.36	1.740	0.518	10606.9	0.231	0.192	0.106	0.096	435.2	7.31	-0.044	9.43	1.168	
6.00	2.583	2.45	-.23	3.39	3.45	14.57	1.898	0.565	11599.3	0.218	0.179	0.116	0.104	519.1	7.14	-0.028	8.62	1.274	
6.50	2.757	3.10	-.10	3.31	3.36	15.79	2.057	0.612	12311.0	0.203	0.165	0.123	0.110	596.9	6.97	-0.012	8.12	1.380	
7.00	2.857	3.5	0	3.20	3.25	17.00	2.215	0.660	12666.5	0.188	0.149	0.127	0.112	661.4	6.74	0.0	7.89	1.486	
7.50	2.92	3.75	+.05	3.10	3.13	18.22	2.373	0.706	12834.3	0.173	0.134	0.128	0.112	718.0	6.53	0.006	7.79	1.592	
8.00	2.964	4.00	+.14	3.01	3.00	19.43	2.532	0.754	12901.6	0.158	0.120	0.129	0.111	769.9	6.34	0.017	7.75	1.699	
8.50	2.960	4.30	+.23	2.92	2.87	20.65	2.690	0.801	12731.8	0.144	0.107	0.127	0.107	807.3	6.15	0.028	7.85	1.805	
9.00	2.956	4.55	+.33	2.83	2.76	21.86	2.848	0.848	12564.6	0.133	9.543	0.126	0.104	843.5	5.96	0.040	7.96	1.911	
9.50	2.953	4.75	+.44	2.72	2.63	23.08	3.006	0.895	12414.7	0.124	8.653	0.124	0.101	879.8	5.73	0.053	8.05	2.017	
10.00	2.942	4.85	+.55	2.63	2.54	24.29	3.165	0.942	12220.5	0.115	7.793	0.122	0.097	911.6	5.54	0.066	8.18	2.123	
11.00	2.932	4.80	+.75	2.46	2.38	26.72	3.481	1.036	11895.9	0.101	6.433	0.119	0.091	976.1	5.18	0.091	8.41	2.336	
12.00	2.953	4.70	+.89	2.34	2.27	29.15	3.797	1.130	11689.8	9.048	5.335	0.117	0.085	1046.4	4.93	0.108	8.55	2.548	
13.00	3.005	4.45	+.945	2.22	2.17	31.58	4.114	1.225	11656.8	8.272	4.582	0.117	0.082	1130.4	4.68	0.114	8.58	2.761	
14.00	3.058	4.10	+1.00	2.12	2.10	34.01	4.431	1.319	11616.2	7.601	3.938	0.116	0.078	1213.1	4.46	0.121	8.61	2.973	
15.00	3.159	3.85	+1.05	2.05	2.05	36.44	4.747	1.413	11776.3	7.074	3.440	0.118	0.076	1317.7	4.32	0.127	8.49	3.185	
16.00	3.258	3.60	+1.10	1.98	1.97	38.87	5.064	1.507	11915.9	6.639	3.021	0.119	0.073	1422.2	4.17	0.122	8.39	3.398	

MODEL NO. : 1174 | L.C.G. LOCATION : 68 | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 6-75 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.0000

DATE : 15 Feb. 1969 | SCALE RATIO : 16.84 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = 7.5 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{RISE}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.370	- .05	-.24	3.40	3.43	7.29	0.945	0.282	1496.7	0.124	8.037	0.015	0.012	33.5	7.16	-0.029	66.81	0.637	.668
3.50	.633	- .10	-.50	3.52	3.48	8.50	1.107	0.329	2674.9	0.151	0.108	0.027	0.022	69.8	7.42	-0.060	37.38	0.743	.780
4.00	1.872	+3.2	-.66	3.53	3.56	9.71	1.266	0.377	8643.7	0.242	0.300	0.086	0.081	257.9	7.43	-0.080	11.57	0.849	.891
4.50	1.822	+3.40	-.40	3.47	3.55	10.93	1.424	0.424	8283.2	0.267	0.226	0.083	0.076	278.0	7.31	0.048	12.07	0.955	1.003
5.00	1.778	+3.0	+.25	3.40	3.47	12.14	1.582	0.471	7944.0	0.216	0.175	0.079	0.071	296.3	7.16	0.030	12.59	1.062	1.114
5.50	1.925	+2.70	+.23	3.34	3.40	13.36	1.740	0.518	8533.9	0196	0.157	0.085	0.075	350.1	7.03	0.028	11.72	1.168	1.226
6.00	2.02	+2.62	+.21	3.25	3.30	14.57	1.898	0.565	8869.5	0.178	0.139	0.089	0.077	397.0	6.84	0.025	11.27	1.274	1.337
6.50	2.12	+2.60	+.24	3.17	3.20	15.79	2.057	0.612	9222.5	0.163	0.124	0.092	0.079	447.2	6.68	0.029	10.84	1.380	1.448
7.00	2.233	+2.70	+.29	3.08	3.10	17.00	2.215	0.660	9640.0	0.152	0.114	0.096	0.082	503.4	6.49	0.035	10.37	1.486	1.560
7.50	2.309	+2.85	+.32	3.00	2.98	18.22	2.373	0.706	9866.9	0.141	0.102	0.099	0.083	552.0	6.32	0.039	10.13	1.592	1.671
8.00	2.353	+3.10	+.35	2.90	2.86	19.43	2.532	0.754	9945.0	0.130	9.262	0.100	0.082	593.5	6.11	0.042	10.06	1.699	1.783
8.50	2.400	+3.35	+.40	2.78	2.73	20.65	2.690	0.801	10049.4	0.123	8.519	0.100	0.081	637.2	5.85	0.048	9.95	1.805	1.894
9.00	2.415	+3.60	+.45	2.67	2.61	21.86	2.848	0.848	9995.3	0.115	7.719	0.100	0.079	671.0	5.62	0.054	10.00	1.911	2.006
9.50	2.451	+3.75	+.50	2.60	2.52	23.08	3.006	0.895	10033.7	0.107	6.987	0.100	0.078	710.3	5.47	0.060	9.98	2.017	2.117
10.00	2.468	+3.90	+.55	2.53	2.45	24.29	3.165	0.942	9960.5	0.100	6.290	0.100	0.076	743.0	5.33	0.066	10.04	2.123	2.229
11.00	2.516	+3.90	+.70	2.40	2.35	26.72	3.481	1.036	9907.7	8.948	5.200	0.099	0.072	813.0	5.05	0.085	10.09	2.336	2.452
12.00	2.584	+3,80	+.83	2.28	2.24	29.15	3.797	1.130	9946.9	8.129	4.406	0.100	0.069	890.4	4.80	0.100	10.05	2.518	2.675
13.00	2.683	+3.60	+.87	2.17	2.15	31.58	4.114	1.225	10139.5	7.556	3.860	0.101	0.067	983.3	4.57	0.105	9.86	2.761	2.897
14.00	2.783	+3.30	+.93	2.06	2.05	34.01	4.431	1.319	10355.5	7.151	3.472	0.104	0.066	1081.4	4.32	0.112	9.66	2.973	3.120
15.00	2.933	+2.90	+.95	1.97	1.97	36.44	4.747	1.413	10780.2	6.834	3.174	0.108	0.067	1206.2	4.15	0.115	9.28	3.185	3.343
16.00	3.082	+2.60	+.98	1.92	1.93	38.87	5.064	1.507	11157.2	6.476	2.845	0.112	0.067	1331.6	4.04	0.118	8.96	3.393	3.566

MODEL NO. : 1174 | L.C.G. LOCATION : 6% | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 6-12 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.0000

DATE : 22 Feb. 1969 | SCALE RATIO : 16.84 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = 12.0 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{\text{RISE}}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.387	.00	-.08	3.35	3.42	7.29	0.945	0.282	1579.7	0.132	8.769	0.016	0.013	35.4	7.06	-0.009	63.30	0.637	0.528
3.50	.585	-.15	-.15	3.45	3.46	8.50	1.107	0.329	2447.3	0.143	9.982	0.025	0.020	63.9	7.27	-0.018	40.86	0.743	.616
4.00	.975	-.35	-.27	3.53	3.52	9.71	1.266	0.377	4239.0	0.178	0.136	0.042	0.037	126.5	7.43	-0.033	23.59	0.849	.704
4.50	1.560	.00	-.68	3.53	3.58	10.9	1.424	0.424	6987.0	0.225	0.184	0.070	0.063	234.5	7.43	-0.082	14.31	0.955	.792
5.00	2.652	+2.30	-.68	3.47	3.55	12.14	1.582	0.471	11780.7	0.305	0.264	0.118	0.109	439.4	7.31	-0.082	8.49	1.062	.880
5.50	2.868	+4.00	.00	3.40	3.46	13.36	1.740	0.518	13150.3	0.288	0.248	0.132	0.121	539.5	7.16	0.0	7.60	1.168	.968
6.00	2.489	+3.80	+.45	3.33	3.37	14.57	1.898	0.565	11151.2	0.214	0.175	0.112	0.100	499.1	7.01	0.054	8.97	1.274	1.056
6.50	2.355	+3.00	+.30	3.25	3.30	15.79	2.057	0.612	10354.8	0.177	0.138	0.104	0.090	502.1	6.84	0.036	9.66	1.380	1.144
7.00	2.474	+2.70	+.25	3.16	3.17	17.00	2.215	0.660	10795.6	0.165	0.126	0.108	0.093	563.7	6.66	0.030	9.26	1.486	1.232
7.50	2.511	+2.65	+.24	3.10	3.07	18.22	2.373	0.706	11074.7	0.153	0.114	0.110	0.094	612.3	6.52	0.032	9.08	1.592	1.320
8.00	2.644	+2.90	+.29	3.02	2.96	19.43	2.532	0.754	11320.2	0.141	0.103	0.113	0.095	675.5	6.36	0.035	8.83	1.699	1.408
8.50	2.677	+3.30	+.35	2.94	2.83	20.65	2.690	0.801	11324.5	0.130	9.219	0.113	0.093	738.0	6.19	0.042	8.83	1.805	1.496
9.00	2.691	+3.70	+.42	2.86	2.72	21.86	2.848	0.848	11234.9	0.120	8.209	0.112	0.090	754.3	6.02	0.051	8.90	1.911	1.584
9.50	2.685	+4.1	+.48	2.72	2.63	23.08	3.006	0.895	11099.1	0.113	7.525	0.111	0.088	786.5	5.73	0.058	9.01	2.017	1.672
10.00	2.694	+4.2	+.56	2.65	2.54	24.29	3.165	0.942	10986.2	0.105	6.739	0.110	0.085	819.5	5.58	0.068	9.10	2.123	1.76
11.00	2.76	+4.2	+.75	2.47	2.39	26.72	3.481	1.036	11043.8	9.538	5.801	0.110	0.082	906.2	5.20	0.091	9.05	2.336	1.936
12.00	2.830	+4.05	+.85	2.36	2.27	29.15	3.797	1.130	11067.0	8.601	4.887	0.111	0.079	990.6	4.97	0.103	9.04	2.518	2.112
13.00	2.900	+3.85	+.92	2.25	2.19	31.58	4.114	1.225	11106.1	7.877	4.193	0.111	0.076	1077.0	4.74	0.111	9.00	2.761	2.288
14.00	3.007	+3.70	+.97	2.14	2.15	34.01	4.431	1.319	11351.9	7.404	3.757	0.114	0.75	1185.5	4.51	0.117	8.81	2.973	2.464
15.00	3.13	+3.40	+1.03	2.05	2.03	36.44	4.747	1.413	11625.7	7.009	3.368	0.116	0.074	1300.8	4.32	0.125	8.60	3.185	2.640
16.00	3.266	+3.15	+1.05	1.98	1.97	38.87	5.064	1.507	11959.2	6.655	3.037	0.120	0.073	1426.9	4.17	0.127	8.36	3.398	2.816

MODEL NO. : 1174 | L.C.G. LOCATION : 6% | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 6-20 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.0000

DATE : 23 Feb. 1969 | SCALE RATIO : 16.84 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = 20.0 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{RISE}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.360	.00	-.05	3.34	3.42	7.29	0.945	0.282	1453.0	0.123	7.915	0.015	0.011	32.5	7.03	-0.006	68.82	0.637	.409
3.50	.604	.05	-.11	3.40	3.43	8.50	1.107	0.329	2545.8	0.149	0.106	0.026	0.021	66.5	7.16	-0.013	39.28	0.743	.477
4.00	.954	.10	-.20	3.49	3.47	9.71	1.266	0.377	4144.9	0.178	0.135	0.041	0.036	123.7	7.29	-0.024	24.13	0.849	.545
4.50	1.458	.50	-.32	3.55	3.55	10.93	1.424	0.424	6481.1	0.209	0.168	0.065	0.058	217.6	7.48	-0.039	15.43	0.955	.613
5.00	2.036	1.1	-.42	3.50	3.57	12.14	1.582	0.471	9192.8	0.240	0.200	0.092	0.083	342.9	7.37	-0.051	10.88	1.062	.682
5.50	2.571	1.8	-.43	3.43	3.48	13.36	1.740	0.518	11684.8	0.255	0.216	0.117	0.107	479.4	7.22	-0.052	8.56	1.168	.750
6.00	2.819	2.8	-.40	3.35	3.39	14.57	1.898	0.565	12766.2	0.241	0.202	0.128	0.116	571.4	7.06	-0.485	7.83	1.274	.818
6.50	2.950	3.7	+.12	3.25	3.28	15.79	2.057	0.612	13273.9	0.221	0.183	0.133	0.120	643.6	6.84	0.015	7.53	1.380	.886
7.00	2.922	3.6	+.17	3.16	3.14	17.00	2.215	0.660	12991.9	0.194	0.156	0.130	0.115	678.4	6.56	0.020	7.70	1.486	.954
7.50	2.840	3.4	+.22	3.07	3.00	18.22	2.373	0.706	12441.6	0.169	0.131	0.124	0.108	696.1	6.47	0.266	8.04	1.592	1.023
8.00	2.788	3.65	+.28	2.97	2.86	19.43	2.532	0.754	12041.6	0.151	0.113	0.120	0.102	718.6	6.26	0.034	8.30	1.699	1.091
8.50	2.773	4.0	+.35	2.86	2.72	20.65	2.690	0.801	11829.0	0.138	0.100	0.118	0.099	750.0	6.02	0.042	8.45	1.805	1.159
9.00	2.788	4.30	+.42	2.75	2.60	21.86	2.848	0.848	11768.9	0.129	9.110	0.118	0.097	790.1	5.79	0.051	8.50	1.911	1.227
9.50	2.792	4.60	+.52	2.65	2.50	23.08	3.006	0.895	11654.3	0.120	1.206	0.117	0.094	825.9	5.58	0.063	8.58	2.017	1.295
10.00	2.810	4.75	+.60	2.55	2.43	24.29	3.165	0.942	11618.2	0.113	7.591	0.116	0.092	866.7	5.37	0.073	8.61	2.123	1.364
11.00	2.858	4.78	+.75	2.37	2.33	26.72	3.481	1.036	11612.3	0.102	6.539	0.116	0.089	952.8	4.99	0.091	8.61	2.336	1.500
12.00	2.937	4.50	+.83	2.25	2.22	29.15	3.797	1.130	11710.2	9.362	5.634	0.117	0.087	1048.2	4.74	0.100	8.54	2.548	1.636
13.00	3.007	4.35	+.89	2.15	2.13	31.58	4.114	1.225	11751.6	8.547	4.845	0.118	0.084	1139.6	4.53	0.108	8.51	2.761	1.773
14.00	3.125	4.15	+.94	2.04	2.05	34.01	4.431	1.319	12055.4	8.072	4.393	0.121	0.084	1259.0	4.30	0.114	8.30	2.973	1.909
15.00	3.253	3.95	+.98	1.96	2.98	36.44	4.747	1.413	12373.5	7.619	3.962	0.124	0.083	1384.5	4.13	0.118	8.08	3.185	2.046
16.00	3.398	3.80	+1.02	1.91	2.93	38.87	5.064	1.507	12729.1	7.178	3.546	0.128	0.082	1519.2	4.02	0.123	7.86	3.398	2.182

MODEL NO. : 1174 | L.C.G. LOCATION : 10% | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 10-00 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.000

DATE : 22 Feb. 1969 | SCALE RATIO : 16.84 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = DEEP

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{RISE}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_V	F_{nh}
3.00	.487	0.93	-.04	3.02	3.14	7.29	0.945	0.282	1707.9	0.154	0.109	0.018	0.014	38.2	6.36	-0.005	58.55	0.637	
3.50	.719	0.73	-.07	3.06	3.22	8.50	1.107	0.329	3146.5	0.198	0.154	0.032	0.028	82.1	6.44	-0.008	31.78	0.743	
4.00	1.000	0.88	-.17	3.25	3.33	9.71	1.266	0.377	4398.4	0.198	0.156	0.044	0.039	131.2	6.84	-0.020	22.74	0.849	
4.50	1.355	1.53	-.30	3.36	3.32	10.93	1.424	0.424	6001.5	0.205	0.164	0.060	0.053	201.5	7.08	-0.032	16.66	0.955	
5.00	1.907	2.58	-.41	3.30	3.15	12.14	1.582	0.471	8582.9	0.238	0.197	0.086	0.078	320.1	6.95	-0.050	11.65	1.062	
5.50	2.365	3.73	-.40	3.22	3.01	13.36	1.740	0.518	10701.2	0.250	0.210	0.107	0.097	439.0	6.78	-0.048	9.34	1.168	
6.00	2.548	4.58	-.30	3.10	2.91	14.57	1.898	0.565	11469.4	0.235	0.195	0.115	0.104	513.3	6.53	-0.036	8.71	1.274	
6.50	2.604	5.18	-.20	2.98	2.82	15.79	2.057	0.612	11636.3	0.213	0.173	0.116	0.104	563.2	6.28	-0.024	8.59	1.380	
7.00	2.645	5.58	-.10	2.85	2.73	17.00	2.215	0.660	11724.7	0.195	0.156	0.117	0.104	612.2	6.00	-0.012	8.53	1.486	
7.50	2.680	5.78	.00	2.75	2.63	18.22	2.373	0.706	11771.1	0.178	0.129	0.118	0.103	658.5	5.79	0.0	8.50	1.592	
8.00	2.716	5.88	+.10	2.63	2.52	19.43	2.532	0.754	11833.3	0.166	0.127	0.118	0.102	706.2	5.54	0.012	8.45	1.699	
8.50	2.770	6.03	+.20	2.53	2.43	20.65	2.690	0.801	11978.6	0.156	0.117	0.120	0.102	759.5	5.33	0.024	8.35	1.805	
9.00	2.822	6.23	+.32	2.43	2.34	21.86	2.848	0.848	12117.3	0.148	0.109	0.121	0.102	813.5	5.12	0.039	8.25	1.911	
9.50	2.869	6.33	+.42	2.34	2.27	23.08	3.006	0.895	12379.3	0.140	0.104	0.124	0.104	877.3	4.93	0.051	8.08	2.017	
10.00	2.924	6.43	+.50	2.27	2.22	24.29	3.165	0.942	12379.2	0.133	9.453	0.124	0.102	923.2	4.78	0.060	8.08	2.123	
11.00	2.973	6.33	+.67	2.16	2.17	26.72	3.481	1.036	12355.0	0.117	7.946	0.124	0.099	1013.8	4.55	0.081	8.09	2.336	
12.00	2.987	6.03	+.80	2.07	2.05	29.15	3.797	1.130	12126.6	0.103	6.567	0.121	0.093	1085.5	4.36	0.097	8.25	2.548	
13.00	3.013	5.53	+.87	1.98	1.97	31.58	4.114	1.225	11969.4	9.300	5.545	0.120	0.088	1160.7	4.17	0.105	8.35	2.761	
14.00	3.020	5.13	+.93	1.92	1.92	34.01	4.431	1.319	11686.9	8.289	4.566	0.117	0.082	1220.5	4.04	0.112	8.56	2.973	
15.00	3.093	4.73	+1.00	1.84	1.86	36.44	4.747	1.413	11760.1	7.716	4.019	0.118	0.079	1315.9	3.88	0.121	8.50	3.185	
16.00	3.165	4.43	+1.02	1.76	1.80	38.87	5.064	1.507	11837.9	7.255	3.579	0.118	0.077	1412.9	3.71	0.123	8.45	3.398	

MODEL NO. : 1174 L.C.G. LOCATION : 108 TEMPERATURE : 68.0°F SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 10-75 MODEL LENGTH : 3.50 ft ρ : 1.9364 ROUGHNESS ALLOWANCE : 0.0000

DATE : 16 Feb. 1969 SCALE RATIO : 16.84 μ : 0.10808×10^{-4} FRICTION LINE : A.T.T.C.

WATER DEPTH = 7.5 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{V^{\frac{2}{3}}}$	$\frac{RISE}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.436	1.28	-.22	3.1	3.25	7.29	0.945	0.282	1840.3	0.158	0.113	0.018	0.015	41.2	6.63	-0.027	54.34	0.637	.668
3.50	.872	1.33	-.45	3.30	3.37	8.50	1.107	0.329	3872.0	0.222	0.179	0.039	0.035	101.1	6.95	-0.054	25.83	0.743	.780
4.00	2.11	3.13	-.55	3.32	3.25	9.71	1.266	0.377	9833.3	0.410	0.367	0.098	0.093	293.4	6.99	-0.080	10.17	0.849	.891
4.50	2.429	4.73	-.25	3.28	3.07	10.93	1.424	0.424	11289.1	0.384	0.342	0.113	0.106	378.9	6.78	-0.030	8.86	0.955	1.003
5.00	2.242	4.43	+.20	3.10	2.95	12.14	1.582	0.471	10263.1	0.298	0.257	0.103	0.095	38 d	6.53	0.024	9.74	1.062	1.114
5.50	2.149	4.23	+.22	2.97	2.86	13.36	1.740	0.518	9701.3	0.247	0.206	0.097	0.088	398.0	6.26	0.027	10.31	1.168	1.226
6.00	2.167	4.32	+.20	2.90	2.77	14.57	1.898	0.565	9675.3	0.214	0.174	0.097	0.086	433.0	6.11	0.024	10.34	1.274	1.337
6.50	2.194	4.48	+.21	2.81	2.68	15.79	2.057	0.612	9677.1	0.190	0.150	0.097	0.085	469.2	5.92	0.025	10.33	1.380	1.448
7.00	2.278	4.63	+.27	2.73	2.58	17.00	2.215	0.660	9960.2	0.175	0.135	0.100	0.086	520.1	5.75	0.033	10.04	1.486	1.560
7.50	2.331	4.93	+.32	2.64	2.51	18.22	2.373	0.706	10098.8	0.162	0.122	0.101	0.086	565.0	5.56	0.039	9.90	1.592	1.671
8.00	2.375	5.23	+.38	2.51	2.44	19.43	2.532	0.754	10217.1	0.152	0.113	0.102	0.087	609.7	5.29	0.046	9.79	1.699	1.783
8.50	2.400	5.43	+.45	2.41	2.36	20.65	2.690	0.801	10228.7	0.142	0.103	0.102	0.085	648.6	5.08	0.054	9.78	1.805	1.894
9.00	2.435	5.63	+.50	2.31	2.27	21.86	2.848	0.849	10291.7	0.134	9.529	0.103	0.085	690.9	4.87	0.060	9.72	1.911	2.006
9.50	2.461	5.83	+.53	2.23	2.22	23.08	3.006	0.895	10306.8	0.126	8.740	0.103	0.084	730.4	4.70	0.064	9.70	2.017	2.117
10.00	2.488	5.93	+.57	2.15	2.16	24.29	3.165	0.942	10326.6	0.119	8.076	0.103	0.083	770.3	4.53	0.069	9.68	2.123	2.229
11.00	2.603	5.83	+.65	2.02	2.07	26.72	3.481	1.036	10661.0	0.110	7.164	0.107	0.083	874.8	4.25	0.072	9.38	2.336	2.452
12.00	2.702	5.53	+.72	1.94	2.00	29.15	3.797	1.130	10873.4	9.99	6.190	0.109	0.082	973.3	4.09	0.087	9.20	2.548	2.675
13.00	2.794	5.13	+.82	1.88	1.93	31.58	4.114	1.225	11024.3	9.083	5.314	0.110	0.080	1069.1	3.96	0.099	9.07	2.761	2.897
14.00	2.878	4.63	+.87	1.83	1.88	34.01	4.431	1.319	10958.4	7.858	4.121	0.110	0.074	1144.4	4.06	0.105	9.13	2.973	3.120
15.00	2.961	4.23	+.95	1.80	1.86	36.44	4.747	1.413	11186.6	7.551	3.854	0.112	0.074	1251.7	3.79	0.115	8.94	3.185	3.343
16.00	3.063	3.83	+1.00	1.77	1.82	38.87	5.064	1.507	11310.8	6.954	3.285	0.113	0.071	1350.0	3.74	0.121	8.84	3.398	3.566

MODEL NO. : 1174 | L.C.G. LOCATION : 10% | TEMPERATURE : 68.0°F | SHIP DISPLACEMENT : 100,000 lb

TEST NO. : 10-12 | MODEL LENGTH : 3.50 ft | ρ : 1.9364 | ROUGHNESS ALLOWANCE : 0.0000

DATE : 16 Feb. 1969 | SCALE RATIO : 16.84 | μ : 0.10808×10^{-4} | FRICTION LINE : A.T.T.C.

WATER DEPTH = 12.0 in.

V_M fps	R_{TM} lb	α degrees	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-3}$	C_R $\times 10^{-3}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{\text{RISE}}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.427	+1.03	-.04	3.15	3.21	7.29	0.945	0.282	1795.2	0.155	0.110	0.018	0.015	40.2	6.63	-0.005	55.70	0.637	0.528
3.50	.688	+0.98	-.15	3.23	3.30	8.50	1.107	0.329	2936.1	0.177	0.134	0.029	0.025	76.7	6.80	-0.018	34.06	0.743	.616
4.00	1.085	+1.33	-.30	3.35	3.35	9.71	1.266	0.377	4800.7	0.209	0.166	0.048	0.043	143.2	7.06	-0.036	20.83	0.849	.704
4.50	1.777	+3.13	-.65	3.32	3.20	10.93	1.424	0.424	8075.2	0.273	0.231	0.081	0.074	271.1	6.99	-0.079	12.38	0.955	.792
5.00	2.750	6.13	-.60	3.22	3.05	12.14	1.582	0.471	12734.1	0.352	0.311	0.127	0.119	474.9	6.78	-0.073	7.85	1.062	.880
5.50	2.750	6.13	.00	3.12	2.95	13.36	1.740	0.518	12615.2	0.300	0.260	0.126	0.117	517.6	6.57	0.0	7.93	1.168	.968
6.00	2.470	5.23	+.35	3.03	2.86	14.57	1.898	0.565	11116.3	0.233	0.193	0.111	0.100	497.5	6.38	0.042	9.00	1.274	1.056
6.50	2.381	4.73	+.30	2.93	2.77	15.79	2.057	0.612	10556.1	0.198	0.158	0.106	0.093	511.8	6.17	0.036	9.47	1.380	1.144
7.00	2.383	4.63	+.16	2.82	2.69	17.00	2.215	0.660	10447.5	0.178	0.138	0.105	0.091	545.5	5.94	0.019	9.57	1.486	1.232
7.50	2.448	4.68	+.22	2.73	2.57	18.22	2.373	0.706	10633.9	0.164	0.125	0.106	0.091	594.9	5.75	0.015	9.40	1.592	1.320
8.00	2.505	4.78	+.29	2.63	2.48	19.43	2.532	0.754	10792.0	0.153	0.114	0.108	0.092	644.0	5.54	0.035	9.27	1.699	1.408
8.50	2.570	4.83	+.35	2.52	2.37	20.65	2.690	0.801	10993.9	0.145	0.106	0.110	0.092	697.1	5.31	0.042	9.10	1.805	1.496
9.00	2.594	5.13	+.45	2.43	2.30	21.86	2.848	0.848	10991.2	0.136	9.709	0.110	0.091	737.9	5.12	0.054	9.10	1.911	1.584
9.50	2.628	5.43	+.50	2.34	2.23	23.08	3.006	0.895	11041.0	0.128	8.966	0.110	0.090	782.4	4.93	0.060	9.06	2.017	1.672
10.00	2.672	5.63	+.55	2.26	2.17	24.29	3.165	0.942	11135.4	0.122	8.338	0.111	0.090	830.6	4.76	0.066	8.98	2.123	1.76
11.00	2.746	5.73	+.64	2.13	2.10	26.72	3.481	1.036	11255.1	0.110	7.179	0.113	0.088	923.5	4.49	0.077	8.88	2.336	1.936
12.00	2.797	5.53	+.70	2.03	2.02	29.15	3.797	1.130	11237.4	9.882	6.093	0.112	0.085	1005.9	4.28	0.085	8.90	2.548	2.112
13.00	2.889	5.18	+.77	1.94	1.94	31.58	4.114	1.225	11408.0	9.101	5.336	0.114	0.083	1106.3	4.09	0.093	8.77	2.761	2.288
14.00	2.932	4.83	+.85	1.85	1.88	34.01	4.431	1.319	11354.8	8.351	4.615	0.114	0.080	1185.8	3.90	0.103	8.81	2.973	2.464
15.00	3.004	4.53	+.94	1.79	1.81	36.44	4.747	1.413	11395.6	7.704	3.988	0.114	0.076	1275.1	3.77	0.114	8.78	3.185	2.640
16.00	3.106	4.13	+1.00	1.71	1.69	38.87	5.064	1.507	11961.6	7.328	3.903	0.120	0.081	1427.6	3.60	0.121	8.36	3.398	2.816

MODEL NO. : 1174 L.C.G. LOCATION : 108 TEMPERATURE : 69.0°F SHIP DISPLACEMENT : 100,000 lb

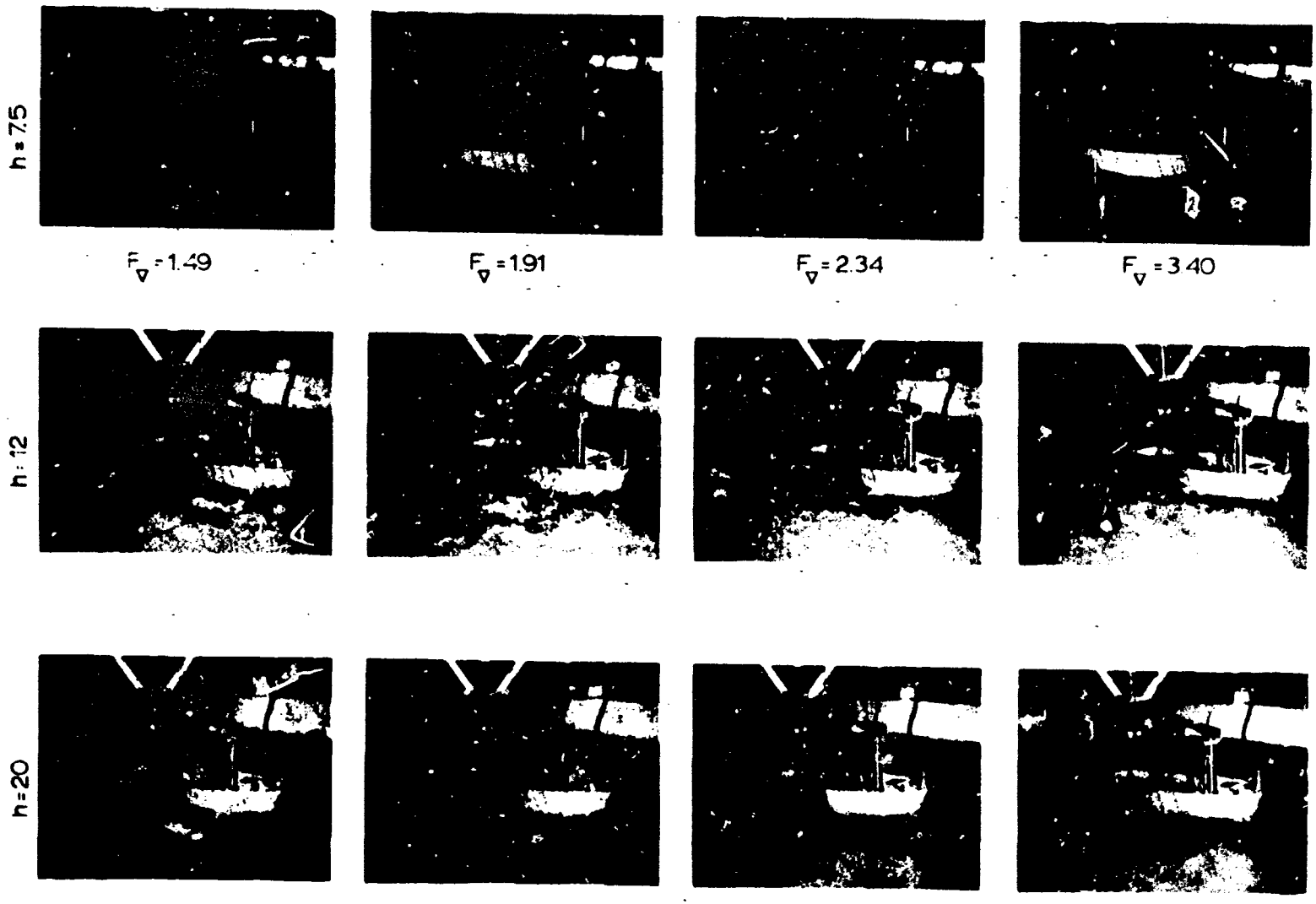
TEST NO. : 10-20 MODEL LENGTH : 3.50 ft ρ : 1.9364 ROUGHNESS ALLOWANCE : 0.0000

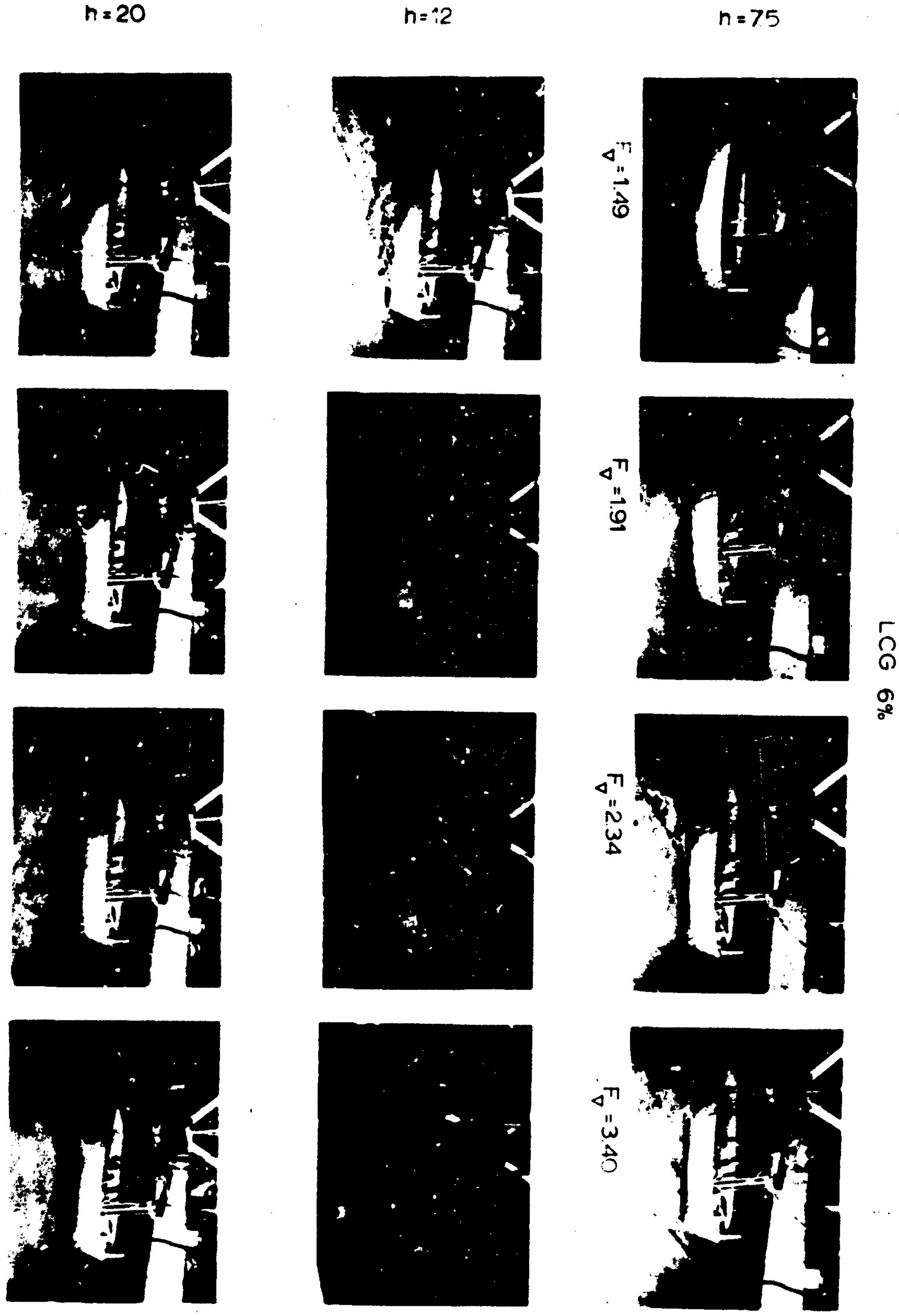
DATE : 22 Feb. 1969 SCALE RATIO : 16.84 μ : 0.10808×10^{-4} FRICTION LINE : A.T.T.C.

WATER DEPTH = 20.0 in.

V_M fps	R_{TM} lb	α degree	CG RISE inch	S ft^2	L_{av} ft	V_K	$\frac{V}{\sqrt{L}}$	F_n	R_{TS} lb	C_T $\times 10^{-1}$	C_R $\times 10^{-1}$	$\frac{R_{TS}}{\Delta}$	$\frac{R_R}{\Delta}$	P_E hp	$\frac{S}{\nabla^{\frac{2}{3}}}$	$\frac{\text{RISE}}{\nabla^{\frac{1}{3}}}$	$\frac{L}{D}$	F_∇	F_{nh}
3.00	.426	1.33	-.03	3.10	3.19	7.29	0.945	0.282	1794.6	0.157	0.112	0.018	0.015	40.2	6.53	-0.004	55.72	0.637	.409
3.50	.678	1.23	-.10	3.15	3.27	8.50	1.107	0.329	2935.4	0.181	0.137	0.029	0.025	76.6	6.63	-0.012	34.07	0.743	.477
4.00	.970	1.18	-.20	3.30	3.37	9.71	1.266	0.377	4244.8	0.189	0.147	0.042	0.037	126.7	6.95	-0.024	23.56	0.849	.545
4.50	1.355	1.53	-.33	3.32	3.16	10.93	1.424	0.424	5926.5	0.208	0.164	0.059	0.052	198.9	6.99	-0.040	16.87	0.955	.613
5.00	1.922	3.03	-.47	3.17	3.03	12.14	1.582	0.471	8680.3	0.250	0.209	0.087	0.079	323.8	6.68	-0.057	11.52	1.062	.682
5.50	2.472	4.93	-.45	3.06	2.92	13.36	1.740	0.518	11265.4	0.275	0.234	0.113	0.103	462.2	6.44	-0.054	8.88	1.168	.750
6.00	2.796	5.63	-.35	2.95	2.83	14.57	1.898	0.565	12740.8	0.271	0.231	0.127	0.117	570.2	6.21	-0.042	7.85	1.274	.818
6.50	2.815	5.63	-.05	2.85	2.75	15.79	2.057	0.612	12715.6	0.241	0.201	0.127	0.115	616.5	6.00	-0.006	7.86	1.330	.886
7.00	2.75	5.43	+.15	2.77	2.65	17.00	2.215	0.660	12267.0	0.209	0.169	0.123	0.109	640.5	5.83	0.018	8.15	1.436	.954
7.50	2.70	5.53	+.27	2.68	2.56	18.22	2.373	0.706	11905.8	0.185	0.145	0.119	0.104	666.1	5.64	0.033	8.40	1.592	1.023
8.00	2.701	5.68	+.33	2.62	2.50	19.43	2.532	0.754	11762.6	0.166	0.127	0.118	0.101	701.9	5.52	0.040	8.50	1.699	1.091
8.50	2.716	5.83	+.37	2.56	2.44	20.65	2.690	0.801	11695.9	0.151	0.112	0.117	0.099	941.6	5.39	0.045	8.55	1.805	1.159
9.00	2.760	6.08	+.45	2.48	2.39	21.86	2.848	0.848	11785.9	0.141	0.103	0.118	0.099	791.2	5.22	0.054	8.48	1.911	1.227
9.50	2.804	6.28	+.52	2.40	2.34	23.08	3.006	0.895	11883.2	0.133	9.523	0.119	0.098	842.1	5.05	0.063	8.42	2.017	1.295
10.00	2.848	6.43	+.57	2.34	2.29	24.29	3.165	0.942	11956.6	0.125	8.739	0.120	0.097	891.9	4.93	0.069	8.36	2.123	1.364
11.00	2.925	6.33	+.67	2.23	2.18	26.72	3.481	1.036	12049.2	0.112	7.396	0.121	0.095	988.7	4.70	0.081	8.30	2.336	1.500
12.00	2.968	6.03	+.75	2.10	2.08	29.15	3.797	1.130	12005.1	0.101	6.365	0.120	0.092	1074.6	4.42	0.091	8.33	2.548	1.636
13.00	3.006	5.53	+.83	2.00	2.00	31.58	4.114	1.225	11916.3	9.185	5.441	0.119	0.087	1155.6	4.21	0.100	8.39	2.761	1.773
14.00	3.089	5.13	+.91	1.90	1.90	34.01	4.431	1.319	12050.9	8.567	4.838	0.120	0.086	1258.5	4.00	0.110	8.30	2.973	1.909
15.00	3.163	4.73	+.95	1.80	1.80	36.44	4.747	1.413	12153.2	8.066	4.347	0.122	0.084	1359.8	3.79	0.114	8.23	3.185	2.046
16.00	3.273	4.43	+1.00	1.71	1.71	38.87	5.064	1.507	12431.2	7.722	4.012	0.124	0.084	1483.7	3.60	0.121	8.04	3.398	2.182

LCG 2%





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LCG 6%

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LCG 10%

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DATE

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