NAVY DEPARTMENT

THE DAVID W. TAYLOR MODEL BASIN

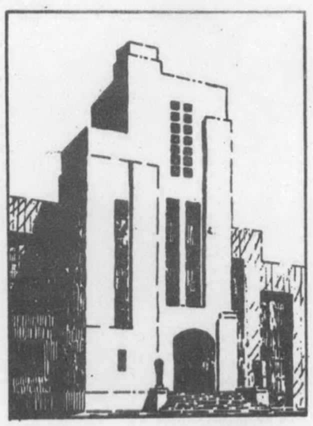
WASHINGTON 7, D.C.

SGT. TRUMAN O. OLSON (YMP-2) EQUIPPED WITH VOITH-SCHNEIDER CYCLOIDAL PROPELLERS STANDARDIZATION TRIAL ANALYSIS AND MODEL RESISTANCE TEST RESULTS

By

George K. Brown

Prepared for The Board of
Inspection and Survey



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July 1953 Report No. C-583

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SGT. TRUMAN O. OLSON (YMP-2)

INTRODUCTION

The standardization trials of the Sgt. Truman O. Olson (YMP-2), an experimental controlled mine planting prototype utilizing cycloidal propeller drive were authorized by the Chief of Naval Operations, (1)*. The Voith-Schneider cycloidal propellers installed on the YMP-2 were captured enemy equipment secured by the Transportation Corps Technical Team of the U.S. Army of Occupation at Heidenheim, Germany, during World War II and were shipped to the United States for evaluation. Figure 1 is a photograph of the YMP-2 taken in dry dock showing the propeller installation. The purpose of these trials was to evaluate the design and performance characteristics of this mine planter. Standardization trials on YMP-2 were conducted under the supervision of the Board of Inspection and Survey, in accordance with the trial agenda letter, over the measured mile course at Kent Island, Maryland, on 21-25 May 1951 (2). Preliminary standardization curves and data were furnished the Board for distribution (3).

A wooden model, 11.3 feet in length, Model No. 4398, was constructed to represent as nearly as practicable the hull of the YMP-2. Because of the large expense involved in manufacturing two model cycloidal propellers, a resistance test only was conducted with Model No. 4398.

The ship trial data have been analyzed and corrected to zero wind and current, but no density correction has been applied to these data. Since there were no self propulsion tests conducted with the model, no ship and model comparison has been made.

APPARATUS AND METHODS FOR OBSERVING TRIAL DATA

During the standardization trials, measurements were made of shaft revolutions, shaft torque and elapsed time while traversing the measured mile. The interval of time required by the vessel to traverse the measured mile on each run was timed by three observers each equipped with a contact maker connected to a navy chronograph. The average of the three chronograph time records was used in calculating the speed of the vessel. The revolutions per mile of each propeller shaft were indicated by Smith-Cummings mechanical counters and were recorded by Taylor printing counters. The contact maker of both the forward deck observer and the after deck observer actuated the Taylor printing counters while the contact maker of the mid-ship deck observer actuated the Smith-Cummings mechanical counters. The total revolutions per mile for each observer as recorded by the Taylor printing counters were divided by their respective observer elapsed times to determine the average shaft revolutions per minute (RPM) for each shaft. RPM from Smith Cummings mechanical counters was used for standby data only. The torque on each shaft was measured by DTMB Magnetic Micrometer MK. II indicating type torsionmeters. Shaft horsepower (SHP) was

* Numbers correspond to references on page 6.

computed from the shaft torque and average RPM. A standard 3-cup Friez anemometer connected electrically to the chronograph was installed on the vessel to determine the relative wind velocity. The apparent wind direction indicator was mounted on the yard arm and read from the deck below.

SHIP TRIAL AND MODEL TEST CONDITIONS

The hull of the vessel was cleaned and painted prior to undocking 17 May 1951 at the Norfolk Naval Shipyard, Portsmouth, Virginia. During the docking period from 9 May to 17 May the entire underwater body was wet sandblasted and sprayed with three undercoats of anti-corrosive paint, formula 14 and one coat of hot plastic anti-fouling paint, formula 15 HP. The air temperature varied from 63° to 80° F. during this painting.

The model frictional resistance was calculated from Schoenherr's formulation. A resistance test of Model No. 4398 was run with the model at a displacement equivalent to 595 tons displacement and a trim equivalent to 6 inches by the stern for the ship. Roughness allowance coefficients of 0.0004, 0.0006, 0.0008 and 0.0010 were used to determine a family of effective horsepower (EHP) curves. These curves are shown in Figure 2.

The principal dimensions and characteristics of the ship and information on the conditions that prevailed during the trials are given in Tables 1 and 2.

TABLE 1

SHIP CHARACTERISTICS

Length on waterline (LWL)	127.5 ft.
Maximum Beam at (LWL)	35.0 ft.

Appendages: Centerline skeg and propellers.

PROPELLER CHARACTERISTICS

Type	Voith-Schneider Cycloidal
BuShips Dwg. No.	Index Nos. 3,156,000 - 3,156,123 3,156,125 - 3,156,261
Number of Propellers	2
Speed reduction of Shaft RPM to Propeller RPM	3.28:1
Orbit Diameter	70.87 in.
Length of Blades	39.37 in.
Max. blade chord width-bottom	9.00 in.
Max. blade chord width-top	15.00 in.
Max. blade thickness-bottom	0.75 in.
Max. blade thickness-top	3.50 in.
Manufacturer	J.M. Voith Machine Works, Heidenheim, Germany

TABLE 2

SHIP TRIAL CONDITIONS

Trial Course: Kent Island, Maryland

Length of Trial Course: 6080 ft.

Depth of Water: 50 ft.

Ship underbody paint: Formula 15 HP (Hot Plastic)

	Full Load	Light Load
Date of Trial, 1951	21-24 May	25 May
Days out of Dock	4 - 7	8
Displacement in Tons	595	545
Mean Draft in ft.	9.78	9.30
Trim in inches, by stern	6	-
Trim in inches, by bow	-	2
Wetted Surface in sq. ft.	4797	4625
Specific Gravity of Sea Water	1.005	1.007
Temperature of Sea Water, °F.	65	63
Wind (Beaufort Scale)	2 - 4	0 - 1

DISCUSSION OF TRIAL RESULTS

The ship trials were carried out by making the usual three runs over the mile at several different speeds with propeller pitch settings of 100, 80, 60 and 40 per cent at full load displacement and at 100 and 10 per cent at light displacement. Air was injected to the propeller rotor wells during all of these trials. The propeller pitch setting of 100 per cent was repeated in the full load displacement condition without air injection to the propeller rotor wells. All standardization data are listed in Tables 3 and 4 Appendix 1 and are shown in Figure 3. Appendix 2 contains a description of the method of reducing torque data to shaft horsepower. The standardization data have been reduced to standard model basin conditions of zero relative wind and zero current by using a method described by Pitre (4). This method is outlined in some detail in Appendix 3. The summary of standardization data are given in Tables 5 and 6 of Appendix 4.

The propeller pitch drifted during the trials of 24 May while at 60 per cent propeller pitch setting with air injection to the propeller rotor wells. The two trials at 60 per cent propeller pitch setting were conducted on succeeding days and with a different air pressure to the propeller rotor wells. It is believed that these conditions may account for the discrepancy in these two trials as shown in Figure 3.

The speed reduction of shaft RPM to propeller RPM is 3.28: 1 Since the revolution counters and torsionmeter husks were located on the shaft, all data are listed as shaft RPM and curves are plotted on shaft RPM. The values for SHP do not include the power loss in the cycloidal propelling mechanism, which is of an indeterminate value.

In order to determine the no load power comsumption of the propeller, SHP measurements were made with zero propeller pitch setting both with and without air injection to the rotor wells. These data were obtained while the ship was anchored in 35 feet of water with a current running of approximately 0.3 knots. The results of this no load test are given in Table 7 of Appendix 4 and are shown in Figure 4.

An air pressure was applied to each propeller rotor well to evacuate the water from the rotor well during the trials "with air injection to rotor wells" as follows:

Date	Air pressure in lbs/sq.in.
21, 22 May 1951	10
23 May 1951	7
24, 25 May 1951	4

REFERENCES

(1) OPNAV ltr Op 436/mlp Ser 76P43 of 19 Jan. 1951.

(2) Joint ltr BuShips YMP-2(430) EN8/A2-6 Ser 430-85; INSURV YMP-2/S8 Ser 275P45 of 21 Mar. 1951.

(3) DTMB CONF. ltr C-S8/YMP-2 (527:GKB:mmb) Ser 0258 of 6 Mar. 1952.

(4) "Trial Analysis Methods" by A.S. Pitre, Trans. Soc. Naval Arch. & Marine Engrs., Vol. 40, 1932.

Figure 1 - Stern View of the SGT. TRUMAN O. OLSON (YMP-2) Showing the Location of Propellers.

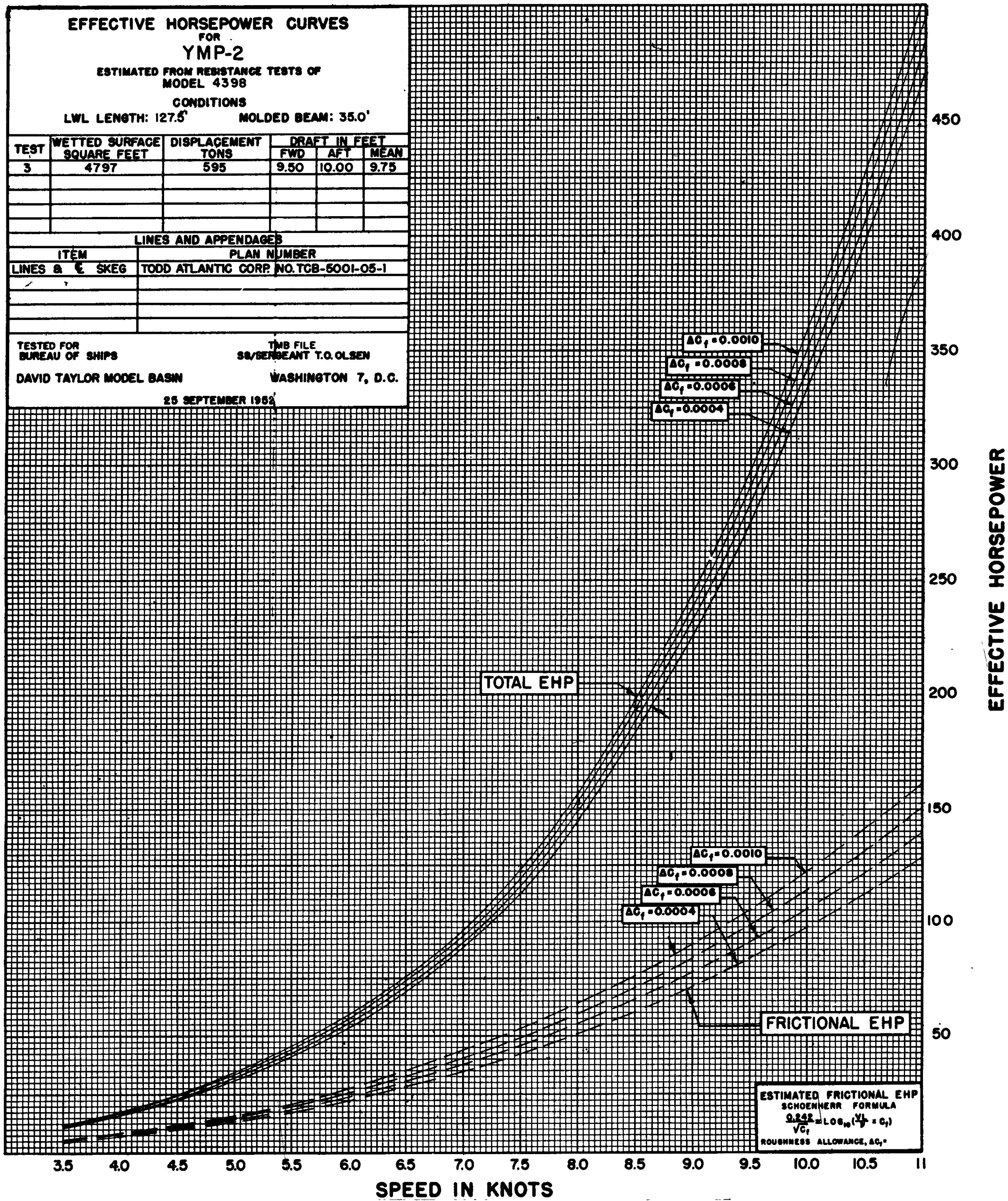

Figure 2 - Effective Horsepower Curves from Resistance Test 3 of Model 4398 Representing the SGT. TRUMAN O. OLSON at a Displacement of 595 Tons.

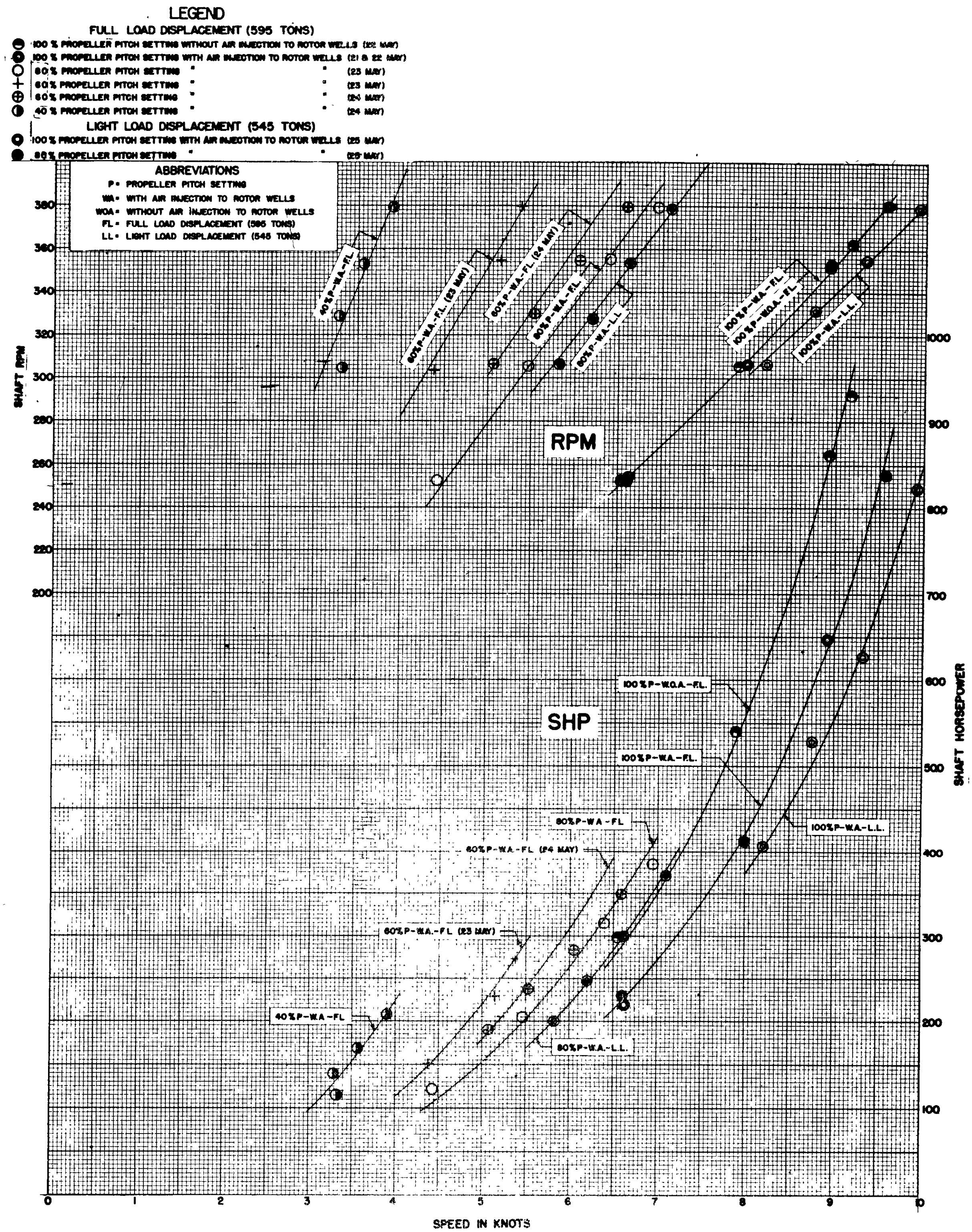

Figure 3 - Shaft Horsepower and RPM Curves for Standardization Trials of SGT. TRUMAN O. OLSON (YMP-2).

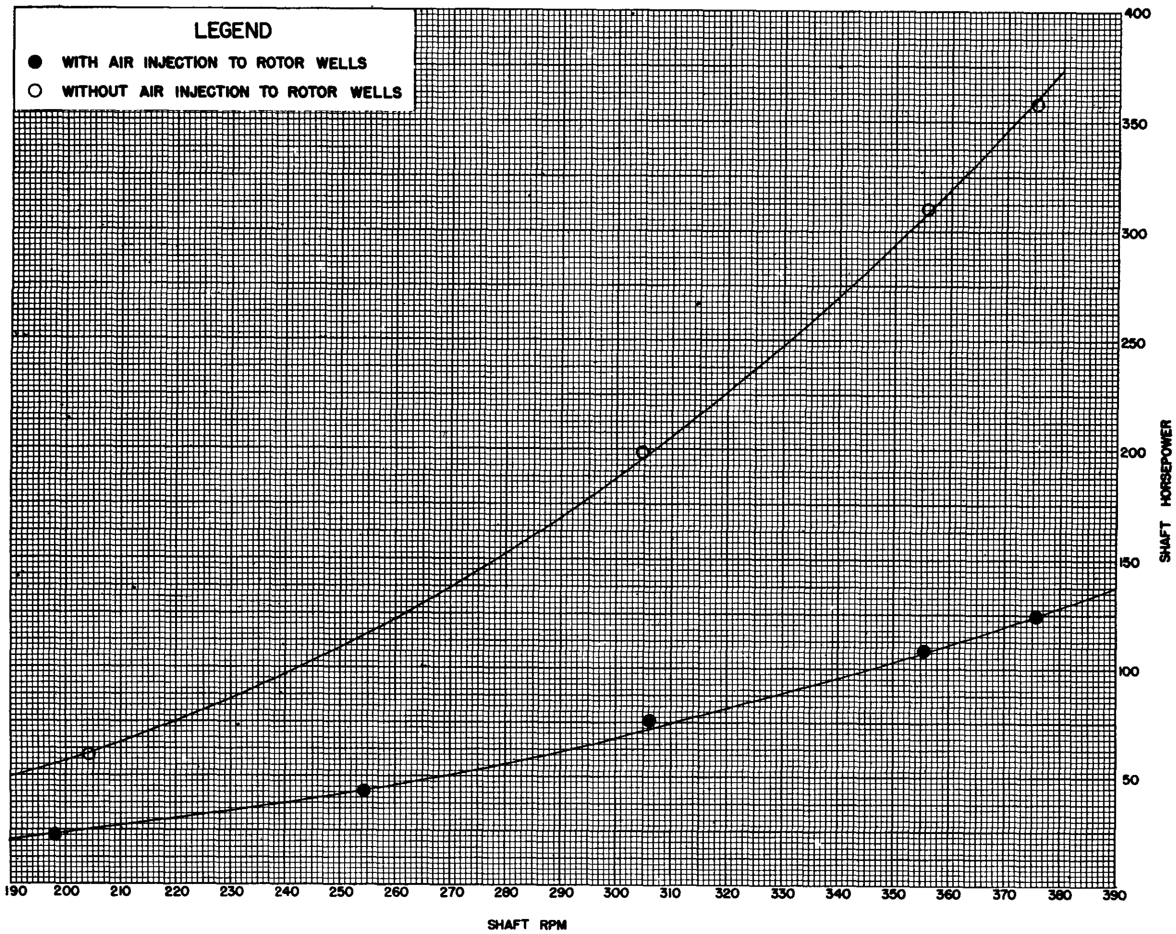

Figure 4 - Shaft Horsepower vs RPM Curves of the SGT. TRUMAN O. OLSON (YMP-2) for the No Load Condition with Zero Propeller Pitch Setting.

APPENDIX 1

TABLE 3

Standardization Data from Trials SGT. TRUMAN O. OLSON (YMP-2)

Run Number and Direction	Time at Start of Run LST	Observed Speed (V_o) Knots	Relative Wind Velocity (W_a) Knots	Relative Wind Direction Degrees	Corrected Speed Through Water (V_w) Knots	Shaft RPM Stbd	Shaft RPM Port	Shaft RPM Avg.	Torsionmeter Reading Stbd	Torsionmeter Reading Port	SHP Stbd	SHP Port	SHP Total
					21 May 1951								
					100% Propeller Pitch Setting with Air Injection to Rotor Wells - Full Load Displacement								
2N	17-29-06	6.88	13.7	350	6.61	253.86	254.04	253.95	146.48	165.49	104	116	221
3S	17-44-45	6.18	4.3	090	6.62	254.08	254.26	254.17	143.09	161.95	103	113	216
4N	18-00-36	6.94	14.8	340	6.62	254.30	254.42	254.36	148.26	166.58	106	116	222
					6.62			254.16					219
					22 May 1951								
4S	10-45-18	8.31	17.8	000	7.99	304.66	308.42	306.54	217.0	274.2	187	232	419
5N	10-59-01	7.28	1.8	130	7.98	304.43	308.07	306.25	211.2	264.3	182	224	406
6S	11-13-01	8.77	18.2	000	7.98	304.36	308.07	306.22	215.9	272.8	186	231	417
					7.98			306.31					412
7N	11-27-30	7.88	2.4	180	8.92	354.57	349.10	351.84	298.9	353.0	300	339	639
8S	11-40-15	9.85	19.8	000	8.92	354.79	349.15	351.97	305.8	359.6	307	345	652
9N	11-53-09	7.83	2.1	160	8.91	354.39	348.75	351.57	299.8	358.8	300	344	644
					8.92			351.84					647
10S	12-57-53	10.53	19.3	350	9.55	379.98	378.80	379.39	363.0	435.9	390	454	844
11N	13-10-09	8.49	2.2	050	9.56	380.83	379.33	380.08	359.1	426.5	387	445	832
12S	13-22-41	10.52	20.7	350	9.56	380.87	379.32	380.10	362.0	436.1	390	455	845
					9.56			380.27					838
					100% Propeller Pitch Setting without Air Injection to Rotor Wells - Full Load Displacement								
13N	13-45-22	8.22	3.8	090	9.16	361.23	363.42	362.33	422.8	492.6	432	492	924
14S	13-57-51	9.95	20.4	350	9.16	361.52	363.36	362.44	432.5	496.0	442	496	938
15N	14-13-27	8.22	3.9	220	9.15	361.13	363.13	362.13	425.0	483.2	434	482	916
					9.16			362.34					930
16S	14-29-41	9.52	21.5	000	8.93	354.97	351.39	353.18	417.4	463.7	419	448	867
17N	14-43-25	8.22	7.6	120	8.93	354.98	351.31	353.15	411.1	458.1	412	442	854
18S	15-00-22	9.49	20.0	350	8.93	355.18	351.41	353.30	421.3	462.9	423	447	870
					8.93			353.19					861
19N	15-16-30	7.28	5.9	130	7.88	303.07	307.98	305.53	279.2	348.4	239	295	534
20S	15-37-18	8.21	18.9	350	7.88	302.97	307.81	305.39	285.7	351.6	247	298	545
21N	15-53-35	7.52	6.5	140	7.88	302.99	307.83	305.41	281.7	346.8	241	294	535
					7.88			305.43					540
24N	17-19-38	6.77	7.5	170	6.52	247.78	255.78	251.78	181.0	233.5	127	164	291
25S	17-39-08	5.69	20.7	000	6.52	247.75	255.83	251.79	187.7	241.3	131	170	301
26N	17-58-10	7.17	8.5	180	6.60	253.95	255.92	254.94	191.7	230.2	138	162	300
					6.54			252.58					298
					100% Propeller Pitch Setting with Air Injection to Rotor Wells - Full Load Displacement								
27S	18-20-41	5.48	21.9	000	6.60	249.32	255.74	252.53	143.5	190.7	101	134	235
28N	18-39-42	7.24	9.0	160	6.60	249.25	255.29	252.27	136.2	181.1	96	127	223
29S	18-56-39	5.36	22.0	000	6.60	249.26	255.72	252.49	146.0	195.1	103	137	240
					6.60			252.39					230
					23 May 1951								
					80% Propeller Pitch Setting with Air Injection to Rotor Wells - Full Load Displacement								
1S	08-52-37	3.58	5.4	130	4.43	247.85	256.99	254.42	88.63	79.91	62	56	118
2N	09-16-26	4.96	10.9	000	4.43	247.79	256.97	252.38	91.84	82.31	64	58	122
3S	09-37-56	4.00	4.1	260	4.43	247.54	256.79	252.17	91.28	81.08	64	57	121
					4.43			252.34					121
4N	10-03-02	5.66	10.9	020	5.48	306.67	307.28	306.98	131.93	111.11	114	94	208
5S	10-24-32	5.35	1.8	300	5.45	303.97	307.19	305.58	125.42	111.56	108	94	202
6N	10-47-22	5.32	8.2	030	5.46	304.09	307.33	305.71	127.13	112.79	109	95	204
					5.46			305.96					204
7S	11-10-35	6.96	-	-	6.39	357.72	353.40	355.56	166.95	145.31	169	141	310
8N	11-31-38	5.49	10.7	000	6.39	357.66	353.36	355.51	174.98	145.41	177	141	318
9S	11-51-47	7.37	3.1	320	6.39	357.72	353.34	355.53	169.85	146.31	172	142	314
					6.39			355.53					315
10N	12-08-18	5.39	12.6	350	6.94	380.14	379.24	379.69	189.80	178.85	204	186	390
11S	12-27-50	8.29	4.8	330	6.94	380.16	379.18	379.67	188.13	170.83	202	178	380
12N	12-45-31	5.34	13.3	020	6.94	380.32	379.16	379.74	190.97	174.59	205	182	387
					6.94			379.69					384
					60% Propeller Pitch Setting with Air Injection to Rotor Wells - Full Load Displacement								
13S	13-37-15	6.77	5.6	100	5.38	380.54	379.40	379.97	132.66	119.00	143	124	267
14N	14-02-03	3.85	6.7	020	5.38	380.42	379.22	379.82	139.25	120.92	150	126	276
15S	14-24-47	6.87	6.6	190	5.38	380.47	379.10	379.79	139.09	119.05	150	124	274
					5.38			379.85					273
16N	14-46-23	3.46	14.8	000	5.14	353.48	356.14	354.81	125.36	109.53	125	107	232
17S	15-13-07	6.19	39.7	140	5.14	353.37	356.10	354.74	119.74	106.90	120	105	225
18N	15-35-56	3.77	14.9	340	5.14	353.44	356.22	354.83	123.72	108.76	124	107	231
					5.14			354.78					228
19S	15-59-54	5.10	4.7	170	4.39	303.80	304.70	304.25	95.10	80.92	82	68	150
20N	16-25-16	3.13	15.5	000	4.39	301.17	304.45	302.81	97.85	82.42	83	69	152
					4.39			303.53					151

APPENDIX 1

TABLE 4

Standardization Data from Trials SGT. TRUMAN O. OLSON (YMP-2)

Run Number and Direction	Time at Start of Run LST	Observed Speed (V_o) Knots	Relative Wind Velocity (W_a) Knots	Relative Wind Direction Degrees	Corrected Speed Through Water (V_w) Knots	Shaft RPM Stbd	Shaft RPM Port	Shaft RPM Avg.	Torsionmeter Reading Stbd	Torsionmeter Reading Port	SHP Stbd	SHP Port	SHP Total
24 May 1951													
60% Propeller Pitch Setting with Air Injection to Rotor Wells - Full Load Displacement													
1S	08-48-37	5.54	19.4	140	5.06	304.52	308.03	306.28	97.45	108.92	84	92	176
2N	09-08-53	3.84	23.3	330	5.06	304.52	308.18	306.35	114.24	119.66	98	101	199
3S	09-33-26	5.72		140	5.06	304.49	308.03	306.26	99.34	110.06	86	93	179
					5.06			306.31					189
4N	09-52-40	4.37	22.1	330	5.53	328.89	330.97	329.93	131.48	134.25	122	122	244
5S	10-13-08	6.11	13.7	140	5.53	328.90	330.99	329.95	122.78	127.13	114	116	230
6N	10-32-47	4.48	18.9	330	5.53	329.16	331.11	330.14	130.14	133.58	121	122	243
					5.53			329.99					237
7S	10-53-06	6.64	11.4	130	6.05	354.49	354.59	354.54	137.03	149.43	137	146	283
8N	11-13-20	4.82	17.4	330	6.05	354.39	354.41	354.40	142.61	150.20	143	146	289
9S	11-35-39	7.11	9.0	150	6.05	354.37	354.36	354.37	134.21	144.18	134	140	274
					6.05			354.43					283
10N	11-53-52	5.18	16.2	340	6.58	379.57	379.97	379.77	166.72	174.99	179	183	362
11S	12-11-48	7.72	3.5	280	6.58	379.61	379.75	379.68	157.61	167.78	169	175	344
12N	12-29-30	5.15	11.6	340	6.57	379.41	378.76	379.09	157.84	169.59	169	177	346
					6.58			379.56					349
40% Propeller Pitch Setting with Air Injection to Rotor Wells - Full Load Displacement													
13S	13-16-48	5.35	4.0	060	3.90	379.45	379.76	379.61	97.62	97.05	105	101	206
14N	13-42-51	2.58	2.8	290	3.90	379.05	379.48	379.27	99.85	96.36	107	100	207
15S	14-15-49	4.92	12.6	020	3.90	378.98	379.37	379.18	98.01	98.04	105	102	207
					3.90			379.33					207
16N	14-38-09	2.49	5.3	180	3.56	350.68	355.10	352.89	82.10	84.41	81	82	163
17S	15-13-06	4.56	9.4	000	3.56	350.63	355.20	352.92	85.46	87.05	85	85	170
18N	15-37-20	2.56	7.5	260	3.56	350.49	354.98	352.74	85.55	84.68	85	83	168
					3.56			352.87					168
19S	16-10-48	4.18	12.5	150	3.28	327.82	330.38	329.10	75.15	72.75	70	66	136
20N	16-35-48	2.49	17.4	320	3.28	327.89	329.05	328.47	79.61	75.29	74	68	142
21S	17-08-19	4.20	12.4	240	3.28	328.17	329.44	328.81	75.88	72.56	70	66	136
					3.28			328.71					139
22N	17-34-45	2.00	18.3	340	3.31	301.76	305.84	303.80	69.83	67.63	60	57	117
23S	18-11-52	3.85	16.4	170	3.32	301.92	306.91	304.42	65.90	65.81	56	56	112
24N	18-39-54	2.13	19.3	340	3.32	301.98	307.19	304.59	70.14	69.23	60	58	118
					3.32			304.31					115
25 May 1951													
100% Propeller Pitch Setting with Air Injection to Rotor Wells - Light Load Displacement													
1S	08-38-45	7.50	-	-	8.19	306.10	306.03	306.07	214.56	259.13	186	218	404
2N	08-53-01	8.76	17.0	330	8.19	306.19	306.06	306.13	226.41	253.21	196	213	409
3S	09-09-12	7.51	6.0	090	8.21	306.51	307.25	306.88	218.77	253.40	190	214	404
					8.20			306.30					406
4N	09-24-54	9.21	15.1	340	8.72	329.07	331.04	330.06	266.79	309.98	248	282	530
5S	09-39-56	8.13	7.4	060	8.73	330.66	331.15	320.91	253.67	306.92	237	280	517
6N	09-53-46	9.32	15.3	340	8.81	335.97	331.30	333.64	280.06	307.32	266	280	546
					8.75			326.38					528
7S	10-07-55	8.75	8.0	030	9.32	356.62	353.17	354.90	296.06	350.06	298	340	638
8N	10-21-01	9.73	11.7	320	9.32	356.79	352.99	354.89	312.99	349.42	316	339	655
9S	10-34-37	8.87	8.9	030	9.32	356.79	352.96	354.88	310.71	353.81	316	343	556
					9.32			354.89					626
10N	10-49-05	10.25	13.7	340	10.31	379.58	378.85	379.22	367.52	423.09	389	441	830
11S	11-02-16	9.56	12.2	030	9.61	379.62	378.67	379.15	355.95	422.33	382	440	822
12N	11-15-08	10.05	12.8		10.15	379.24	378.42	378.83	358.33	416.71	384	434	818
					9.92			379.09					823
80% Propeller Pitch Setting with Air Injection to Rotor Wells - Light Load Displacement													
13S	12-07-44	6.00	3.6	330	5.82	305.26	306.85	306.06	116.41	116.08	100	98	198
14N	12-25-51	5.32	9.8	030	5.82	305.23	306.85	306.04	118.56	118.76	102	100	202
15S	12-45-24	6.42	5.6	330	5.82	305.28	306.92	306.10	116.15	115.04	100	97	197
					5.82			306.06					200
16N	13-04-37	5.34	5.5	000	6.22	326.34	330.61	328.48	136.47	135.66	126	123	249
17S	13-24-17	7.06	10.6	000	6.22	326.48	330.96	328.72	138.54	133.09	128	121	249
18N	13-43-51	5.16	2.5	290	6.14	326.37	322.35	324.36	135.54	130.97	125	116	241
					6.20			327.57					247
19S	14-05-09	7.62	13.8	000	6.62	354.92	352.80	353.86	155.00	150.64	156	146	302
20N	14-22-47	5.46	2.5	330	6.62	354.85	352.81	353.83	150.50	150.12	151	146	297
21S	14-40-50	7.75	13.0	350	6.62	355.05	352.90	353.98	160.00	140.00	160	144	304
					6.62			353.88					300
22N	14-59-29	5.92	2.7	270	7.09	379.28	378.60	378.94	179.11	168.74	192	176	368
23S	15-17-08	8.16	17.3	350	7.09	379.24	378.50	378.87	184.69	168.75	198	176	374
24N	15-33-05	5.85	4.1	250	7.09	379.22	378.39	378.81	179.19	169.35	192	176	368
					7.09			378.87					371

APPENDIX 2

METHOD OF REDUCING TORQUE DATA TO SHAFT HORSEPOWER

The shaft torque data were obtained by DTMB Magnetic Micrometer (Mark II) indicating torsionmeters using indicators numbered 1 and 2 for shafts 1 and 2 respectively. The section modulus of the shafts was assumed to be 12 x 10^6 since the shafts were not calibrated.

The torsionmeter zeros were obtained by the "drag shaft" method and are listed below for each day of trials.

Date 1951	Torsionmeter Zero Stbd	Torsionmeter Zero Port
21 May	11.5G	9.5R
22 May	11.8G	24.7R
23 May	2.5R	12.1R
24 May	5.6G	11.7R
25 May	6.0G	13.4R

The shaft torque data from the DTMB torsionmeters are converted to SHP by the following method.

1. $$M_t = \frac{G\, J_p\, a}{L}$$

where, M_t is the torque in inch pounds per drum division;

G is the modulus of rigidity in pounds per square inch;

L is the distance between clamping planes in inches;

J_p is the polar moment of inertia;

$$J_p = \frac{\pi\,(OD^4)}{32}$$

where, OD is the outside diameter of shaft in inches;

a is the angle of twist $= \frac{0.00010}{B}$

where, one revolution of drum = 500 divisions

$= \frac{1}{20}$ inches linear movement of transformer coil, one drum division = 0.00010 inches linear movement,

B is the radius of husk transformer core in inches

2. Therefore, $M_t = \frac{0.00010 \pi (OD^4) G.}{32 L B}$

3. SHP = C x N x indicator reading (corrected)

where, SHP is the shaft horsepower;

N is the revolutions per minute of the shaft;

Indicator Reading (corrected) = Indicator readings corrected for the zero readings, and

C is the horsepower constant = $\frac{M_t}{63025}$ x gage factor

where, Gage factor = $\frac{\text{Average Husk Displacement}}{\text{Average Indicator Displacement}}$

APPENDIX 3

METHODS OF TRIAL ANALYSIS TO REDUCE DATA TO STANDARD CONDITIONS

1. The trial data were reduced by Eggert's power method as described by Pitre in (4).

2. The analysis attempts to evaluate the effects of wind and current in order to reduce the data to standard model basin condition: of zero current and zero air resistance. A description of the analys: as regards speed may be summarized as follows:

a. The wind direction coefficient, k, for the observed apparent wind direction is found from the wind resistance test of the YTB 500 model.

b. The horsepower expended in overcoming the wind resistance is calculated from the formula

$$EHP = \frac{R_W\ A\ W_a^2\ V_o\ k}{325.7}$$

where R_W is the specific resistance coefficient from a model test (0.00177) from YTB 500 wind tunnel model tests)

A is the above-water cross-sectional area of the ship (835 sq.ft.)

W_a is the relative wind velocity,

V_o is the speed through the water (second mean of the observed speeds for a three-run group),

k is the wind direction coefficient representing the ratio of increase in axial resistance for any angle of attack, based on the axial resistance for zero angle of attack, and $\frac{1}{325.7}$ is a factor to reduce resistance (pounds) multiplied by speed (knots) to EHP.

c. A curve of slope of EHP against speed is plotted. The increase in EHP per knot change in speed, $\Delta \frac{EHP}{V}$, is read from this curve at the group average speeds.

d. The Δ EHP from Step b is divided by the EHP per knot from Step c, which gives the increment of speed Δ V due to the wind effect

e. These increments of speed are added (subtracted if k is negative) to the observed speeds to find the corrected speeds, V_G, over the ground with no air resistance.

f. The speeds V_G, Step e, corrected for wind effect, are still influenced by the current existing over the trial course during the runs. It has been shown in more detailed papers on trial analysis that if the current varies uniformly, the second mean (weighted average) of the observed speeds in a three-run group at constant RPM is a close approximation to the true speed through the water. Since the RPM varies somewhat over a three-run group, the average RPM for the group is divided by the weighted average V_G to find the average RPM per knot.

g. The RPM for each run is in turn divided by the RPM per knot, Step f, to find the corrected speed through the water V_W.

h. The actual speed through the water, V_{AW}, is corrected speed through the water, V_W, minus the speed correction ΔV due to the wind.

APPENDIX 4

TABLE 5

SUMMARY OF STANDARDIZATION DATA
FROM TRIALS SGT. TRUMAN O. OLSON (YMP-2)
FULL LOAD DISPLACEMENT (595 TONS)

Corrected Speed Through Water Knots V_W	Avg. Shaft RPM	Total SHP	Remarks
100% Propeller Pitch Setting			
6.54	252.58	298	Without Air
7.88	305.43	540	Injection to
8.93	353.20	861	Rotor Wells
9.16	362.34	930	
100% Propeller Pitch Setting			
6.60	252.39	230	With Air
6.62	254.16	219	Injection to
7.98	306.31	412	Rotor Wells
8.92	351.84	647	
9.56	380.27	838	
80% Propeller Pitch Setting			
4.43	252.34	121	With Air
5.46	305.96	204	Injection to
6.39	355.53	315	Rotor Wells
6.94	379.69	384	
60% Propeller Pitch Setting			
4.39	303.53	151	With Air
5.14	354.78	228	Injection to
5.38	379.85	273	Rotor Wells
60% Propeller Pitch Setting (Propeller Pitch Drifted During Trial)			
5.06	306.31	189	With Air
5.53	329.99	237	Injection to
6.05	354.43	283	Rotor Wells
6.58	379.56	349	
40% Propeller Pitch Setting			
3.32	304.31	115	With Air
3.28	328.71	139	Injection to
3.56	352.87	168	Rotor Wells
3.90	379.33	207	

APPENDIX 4

TABLE 6

SUMMARY OF STANDARDIZATION DATA

FROM TRIALS SGT. TRUMAN O. OLSON (YMP-2)

LIGHT LOAD DISPLACEMENT (545 TONS)

Corrected Speed Through Water Knots V_W	Avg Shaft RPM	Total SHP	Remarks
100% Propeller Pitch Setting			
8.20	306.30	406	With Air Injection to Rotor Wells
8.75	331.38	528	
9.32	354.89	626	
9.92	379.09	823	
80% Propeller Pitch Setting			
5.82	306.06	200	With Air Injection to Rotor Wells
6.20	327.57	247	
6.62	353.88	300	
7.09	378.87	371	

APPENDIX 4

TABLE 7

RESULTS OF TRIALS AT ANCHOR

OF SGT. TRUMAN O. OLSON (YMP-2)

ZERO PROPELLER PITCH SETTING

Avg. Shaft RPM	Total SHP	Remarks
Without Air Injection to Rotor Wells		
204.10	60	
257.36	58	Stbd shaft only
304.61	199	
355.78	311	
375.24	358	
With Air Injection to Rotor Wells		
198.02	23	
254.39	43	
306.06	76	
355.47	109	
375.75	125	

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ii, 20 p. incl. tables, figs., refs.

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