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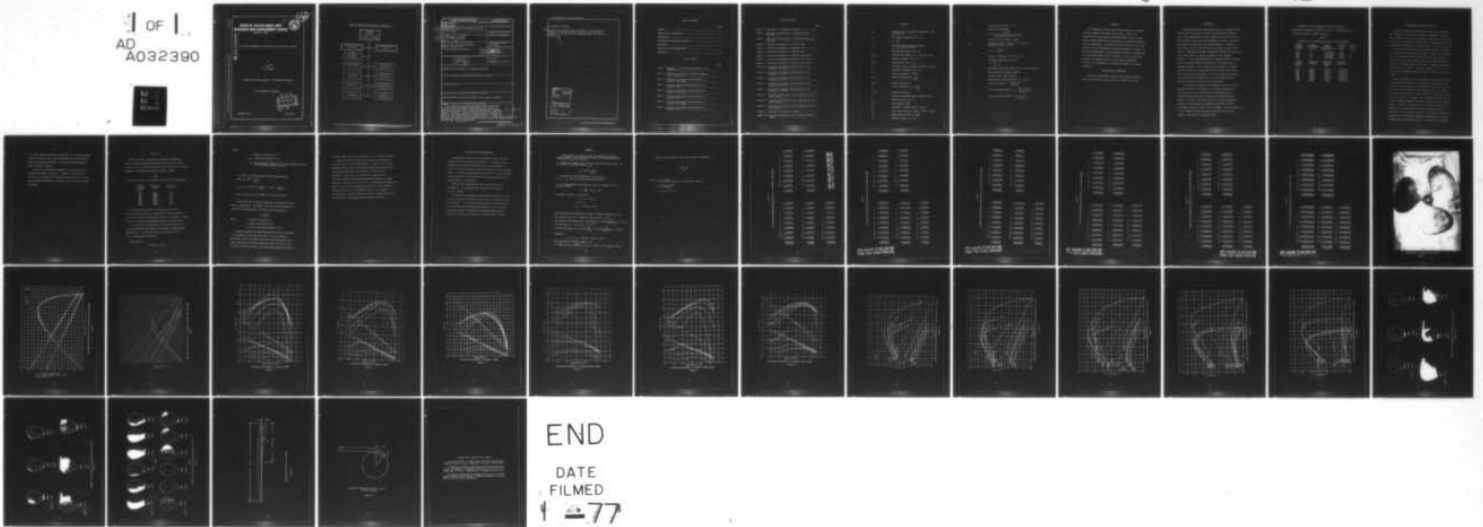
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CAVITATION PERFORMANCE OF PROPELLERS WITH AND WITHOUT CUPPING, (U)
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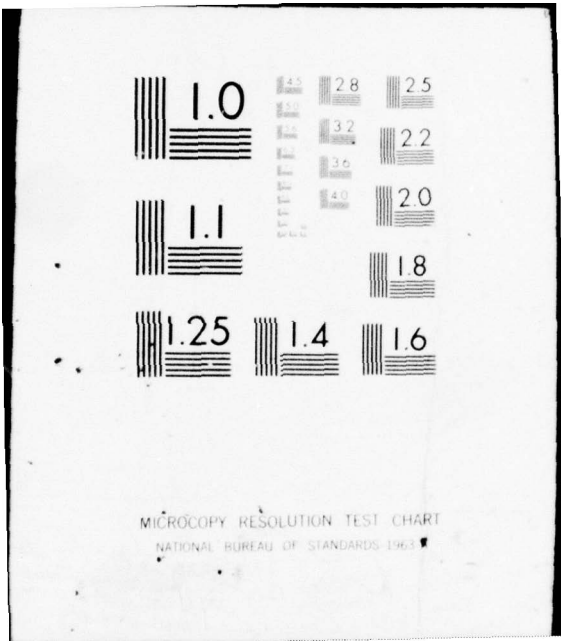
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CAVITATION PERFORMANCE OF PROPELLERS WITH AND WITHOUT CUPPING

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Md. 20084



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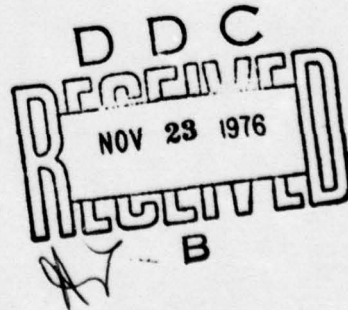
CAVITATION PERFORMANCE OF PROPELLERS WITH AND WITHOUT CUPPING

by

J. G. PECK
and
B. L. FISHER

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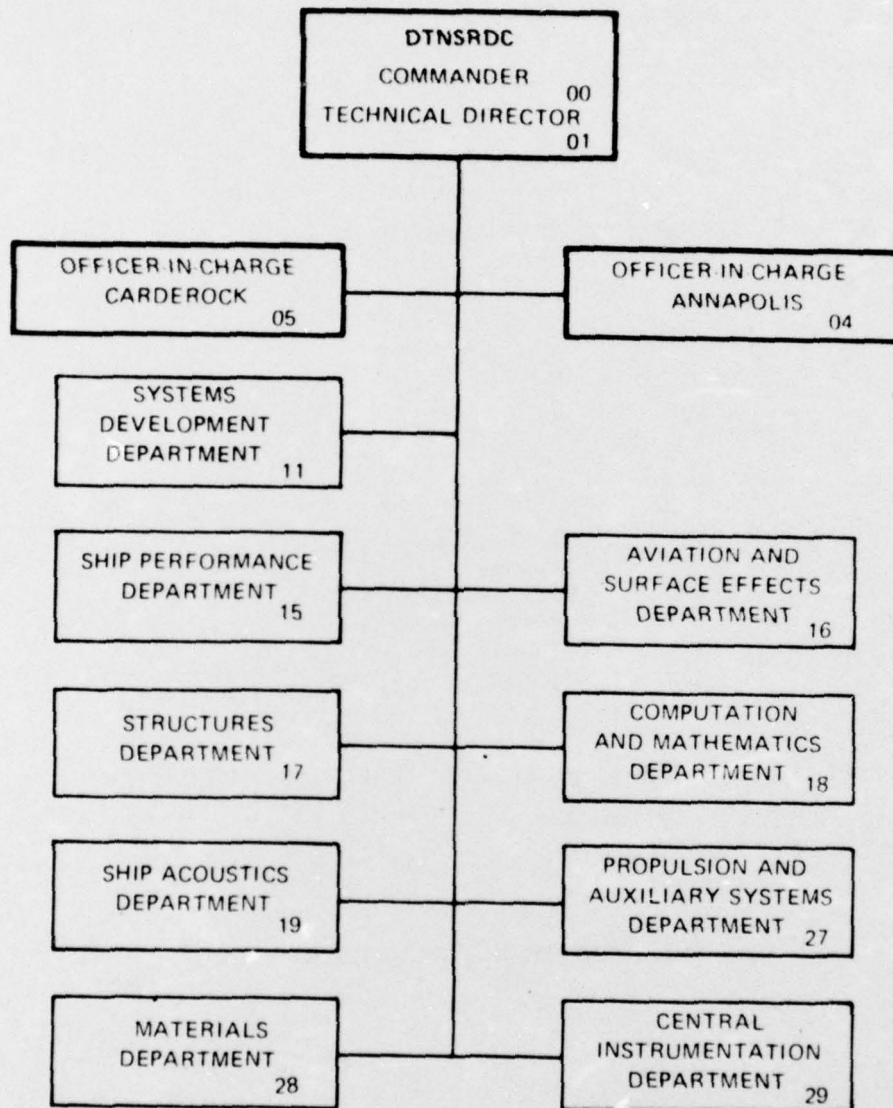
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20. ABSTRACT (Continued)

→ the resulting increase in effective pitch. It is concluded that cupping is an effective means of correcting an underpitched propeller, at the expense of efficiency and danger of increased cavitation.



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NOTATION

A_E	Expanded area of propeller blades (ft ²), (m ²) $A_E = \text{EAR} (A_o)$
A_o	Disc area of propeller (ft ²), (m ²) $A_o = \frac{\pi D^2}{4}$
A_P	Projected area of propeller blades $A_P = A_E (1.067 - 0.229 P/D)$
C	Blade section length (ft), (m)
$C_{0.7}$	Blade section length at 0.7 radius (ft), (m)
D	Propeller diameter (ft), (m)
EAR	Expanded area ratio A_E/A_o
g	Acceleration due to gravity (ft/sec ²), (m/sec ²)
h	Propeller submergence (ft), (m)
J	Advance coefficient $J = V/nD$
K_T	Thrust coefficient $K_T = \frac{T}{\rho n^2 D^4}$
K_T/J^2	Loading coefficient
K_Q	Torque coefficient $K_Q = \frac{Q}{\rho n^2 D^5}$
K_Q/J^3	Powering coefficient
n	Propeller rotational speed (rev/sec), (r/s)
P	Propeller pitch (ft), (m)
P/D	Pitch-diameter ratio
P_A	Atmospheric pressure (lb/ft ²), (N/m ²)
P_H	Static water pressure, $P_H = \rho gh$, (lb/ft ²), (N/m ²)
P_V	Vapor pressure (lb/ft ²), (N/m ²)
T	Propeller thrust (lb), (N)

Q Propeller torque (lb/ft), (N·m)

Q_c Torque load coefficient,

$$Q_c = \frac{2.55 K_Q}{(J^2 + 4.84)(EAR)(1.067 - 0.229 P/D)}$$

v Velocity of boat (ft/sec), (m/sec)

$v_{0.7}$ Resultant velocity of water at 0.7 radius of propeller (ft/sec), (m/sec)

$$v_{0.7}^2 = \frac{J^2 + 4.83}{J^2} v^2$$

x Amount of cupping at 0.7 R, (in), (m)

n Propeller open water efficiency,

$$\eta = \frac{K_T}{K_Q} \frac{J}{2\pi}$$

θ_A Additional pitch angle required for new pitch, degrees

θ_n New required pitch angle, degrees

θ_o Original pitch angle, degrees

ρ Mass Density of water (lb-sec²/ft⁴), (K/m³)

σ Cavitation number, $\sigma = \frac{P_A + P_H - P_V}{(1/2)\rho v^2}$

$\sigma_{0.7}$ Local cavitation number, $\sigma_{0.7} = \frac{P_A + P_H - P_V}{(1/2)\rho v_{0.7}^2}$

τ Thrust load coefficient, $\tau = \frac{T}{(1/2)\rho A_P v_{0.7}^2}$

ABSTRACT

Four commercial propellers were characterized over a range of cavitation numbers and advance coefficients. Three of the propellers were then cupped to different degrees on the trailing edge and characterized over the same range of cavitation numbers and advance coefficients. The results show an increase in K_T , K_Q , and effective pitch corresponding to increasing degrees of cupping. An empirical relationship is derived between the amount of cupping and the resulting increase in effective pitch. It is concluded that cupping is an effective means of correcting an underpitched propeller, at the expense of efficiency and danger of increased cavitation.

ADMINISTRATIVE INFORMATION

This work was performed for Naval Ship Engineering Center, Norfolk Division under Project Order No. N64281-76-PO-6-0005.

INTRODUCTION

Cupped propellers have been manufactured for a number of years and they have become popular for small and medium size pleasure boats. Most manufacturers of small propellers offer one or more of their propeller styles with varying degrees of cupping. Improved performance is claimed for these cupped propellers. Recent full scale trials of the 65' MK III patrol boat appear to support this claim. A significant increase in speed was realized for this craft when a small amount of cupping was applied to her existing propellers. Power measurements prior to cupping, however, indicated that the propellers were not absorbing the full engine power at maximum engine RPM. After cupping these propellers, the maximum available power of the engines was absorbed at the maximum engine RPM, and craft speed increased. It is likely that the increase in power absorbed by the propellers in this case resulted from an effective increase in pitch caused by the cupping.

The cupping of propellers is considered to be an art in the propeller industry. The process (i.e, cupping) increases the effective pitch through deflecting the trailing edge of the propeller-blades (which also increases the trailing edge blade camber). In order to determine the effect of various amounts of cupping on the performance of commercial propellers a limited experimental program was under taken at DTNSRDC. The characteristics of four commercial propellers were determined with and without cupping. The results are reported herein.

The geometry of each propeller along with the range of experimental parameters are shown in Table 1. A photograph of one of these propellers is shown in Figure 1.

TABLE 1

Geometry of the Propellers and Scope of the Experiment

DTNSRDC Propeller Number	Nominal Pitch-Diameter Ratio	Model Propeller Diameter/ins (m)	Expanded Area Ratio	Number of Blades
4685	1.0	12(0.3048)	0.694	3
4686	1.0	12(0.3048)	0.582	3
4687	1.1	12(0.3048)	0.593	3
4688	1.3	12(0.3048)	0.723	3

DTNSRDC Propeller Number	Geometrical Changes	Cavitation Number Range	Advance Coefficient
4685	None	5.8-0.5	0.55-1.05
4685	Cupped	5.8-0.5	0.60-1.05
4686	None	5.8-0.5	0.55-1.05
4686	Cupped	5.8-0.5	0.55-1.05
4687	None	5.8-0.5	0.60-1.15
4687	Cupped	5.8-0.5	0.60-1.15
4688	None	5.8-0.5	0.65-1.40

EXPERIMENTAL PROCEDURE AND RESULTS

Propeller open-water characteristics of the four propellers were obtained in the Center's deep water towing basin. The data were reduced to the usual non-dimensional coefficients of thrust and torque and are presented in Figures 2 and 3. Reynolds number during the open-water characterization varied from 9.0×10^6 to 11.0×10^6 .

Cavitation characteristics of the propellers were obtained in the 24-inch variable pressure water tunnel. Tunnel water velocities for each uncupped propeller were established by setting thrust values in the water tunnel equal to the thrust values obtained in open water at the same advance coefficient. Tunnel pressures were adjusted to cover a range of cavitation numbers from 5.8 to 0.5. These cavitation numbers represent a range of ship speed from 12 to 40 knots.

After the uncupped propeller experiments were completed three of the propellers were cupped in the DTNSRDC propeller shop. The blade outline and thickness of these propellers made it difficult to cup them at radii less than 0.5 or greater than 0.9. As a result the cupping is maximum at 0.7 radius and tapers to zero near the hub and at the blade tip. Propellers 4685, 4686 and 4687 were cupped in different amounts designated respectively as heavy, light and medium cupping. Cavitation characteristics of the cupped propellers were obtained over the same range of cavitation numbers and advance coefficients as the uncupped propellers. The thrust and torque data obtained from the cavitation experiments were reduced to the usual nondimensional coefficients, K_T and K_Q . In addition, efficiencies

(η), thrust loading coefficients (K_T/J^2 and τ_c) and torque loading coefficients (K_Q/J^3 and Q_c) were calculated from faired values of thrust and torque coefficients. All the force coefficients are given in Tables 3 through 8.

Curves of the cavitation performance of the propellers are presented in Figures 4 through 14. Sketches of the extent of cavitation on the propeller blades are shown in Figure 15 for the heavily loaded conditions and in Figure 16 for the lightly loaded conditions.

DISCUSSION

When the curves of cavitation performance are treated as typical propeller series data, values of effective pitch may be assigned to the cupped propellers based upon their thrust producing capability. These results are given in Table 2 below:

TABLE 2

Effective Pitch Ratio of Propellers Based on Thrust Performance

DTNSRDC Propeller Number	Geometrical Changes	Effective Pitch Ratio
4685	NONE	1.00
4685	Cupped	1.15
4686	NONE	1.00
4686	Cupped	1.05
4687	NONE	1.10
4687	Cupped	1.18
4688	NONE	1.30

By correlating the change in effective pitch of these propellers and the amount of cupping done to them, an empirical relationship has been established to calculate the degree of cupping needed to accomplish a predetermined change in effective pitch.

If one associates cupping with the added deflection of the blade trailing edge after cupping (the deflection being measured perpendicular to the nose-tail-line of the blade, at the 0.7 radius), cupping may be defined as:

(See Figure 17)

$$x = (1/2) C_{o.7} \tan \theta_A$$

where

x = amount of cupping at 0.7 R

$C_{0.7}$ = blade chord length at 0.7 R

θ_A = the approximate change in pitch angle between propeller pitch and desired propeller pitch.

If p_n and θ_n are the new pitch and pitch angle desired,

where $\theta_n = \tan^{-1} \left(\frac{p_n}{2\pi r_{0.7}} \right)$

$$\theta_A = \theta_n - \theta_o = \tan^{-1} \left(\frac{p_n}{2\pi r_{0.7}} \right) - \tan^{-1} \left(\frac{p_o}{2\pi r_{0.7}} \right)$$

where θ_o and p_o are the original pitch and pitch angle.

It was found that the proper cupping can be achieved by using a ball or curved anvil. The radius of the ball may be determined by using the following equation (See Figure 18 for definition):

$$r = \frac{x^2 + y^2}{2x}$$

where

r = radius of desired ball

x = amount of cupping at 0.7R

y = 10% of blade chord length at 0.7R

A numerical example for these computations is shown in Appendix A. In cupping the propellers the center of the ball should be positioned at 90% of the chord length from the leading edge of the blade, starting at the hub and progressing toward the tip to 0.9R. From 0.9R to 0.95R the center of the ball moves linearly from 90% of

the chord length to 100% of the chord (i.e., to the trailing edge).

Propeller cupping is a practical method for increasing the effective pitch of an existing propeller. However, there are two potential problem areas. One problem is that the cupping produces a blade trailing edge which is susceptible to trailing edge cavitation. This effect is illustrated by the sketches of cavitation present, under typical operating conditions, on these propellers (See Figures 15, 16, and 17). Also cupped propellers, in general, seem to have a somewhat lower efficiency than propellers designed specifically for the desired pitch. Thus cupping is recommended only when the existing propeller is underpitched and the required higher pitch propeller is not readily available.

CONCLUSION AND RECOMMENDATIONS

An approximate definition of cupping was derived from data obtained using four commercial propellers. It appears that the cupping of an in-service propeller is an effective measure to correct the initial mis-match between the propeller and the powering system. A properly cupped propeller will absorb the available power at the expense of lower efficiency and with the possibility of an increased amount of cavitation.

Based on this limited sample (only four propellers were evaluated), it is recommended that cupping only be used as a corrective measure.

The empirical relationship between cupping and effective pitch, in a strict sense, is valid only for the type of cupping described in this report. If a different method is used to achieve cupping, the conclusions drawn from these experiments may not be valid. A much larger sample of commercially cupped propellers would be required if one desires to arrive at a "general rule of thumb".

APPENDIX A

The procedure to follow in order to determine the amount of cupping needed to raise the effective pitch of an existing propeller to some new value is as follows:

1. Estimate the desired pitch ratio and calculate the new pitch. For this pitch, the new pitch angle, θ_n is

$$\theta_n = \tan^{-1} \left(\frac{P_n}{2\pi r_{0.7}} \right)$$

2. Calculate the required additional pitch angle θ_A :

$$\theta_A = \theta_n - \theta_o, \text{ where } \theta_o \text{ is the original pitch angle.}$$

3. The trailing edge of the propeller should be cupped, at the 0.7 radius, an amount

$$x = \left(\frac{C_{0.7}}{2} \right) \tan \theta_A \text{ [in]}$$

For example consider a propeller of:

$$D = 2.5 \text{ ft (.762 m)}$$

$$P/D = 1.0$$

$$C_{0.7} = 1.458 \text{ ft (.444m)}$$

How much should this propeller be cupped to achieve a desired $P/D = 1.1$?

The original pitch is $P = (D)(P/D) = (2.5 \text{ ft})(1.0) = 2.5 \text{ ft}$

The original pitch angle is $\theta_o = \tan^{-1} \left(\frac{P}{2\pi r_{0.7}} \right) = \tan^{-1} \left[\frac{2.5}{(2)(\pi)(.87)} \right] = 24.453^\circ$

The new pitch is $P = (2.5)(1.1) = 2.75 \text{ ft}$

The new pitch angle is $\theta_n = \tan^{-1} \left(\frac{P}{2\pi r_{0.7}} \right) = \tan^{-1} \left[\frac{2.75}{(2)(\pi)(.87)} \right] = 26.706^\circ$

Therefore:

$$\theta_A = \theta_n - \theta_o = 26.706 - 24.453 = 2.253^\circ$$

Then the amount of cupping needed, x , is

$$x = \left(\frac{C_{0.7}}{2} \right) \tan \theta_A = \left(\frac{1.458}{2} \right) \tan 2.253^\circ = .029 \text{ ft} = .344 \text{ inches (.009 m)}$$

The ball radius needed to effect this amount of cupping is:

$$r = \frac{x^2 + y^2}{2x}$$

where $x = .344$ inches

$y = 10\%$ of blade chord at $0.7 R = 1.749$ in (.0444 m)

$$r = \frac{(.344)^2 + (1.749)^2}{2(.344)}$$

$$= 4.62 \text{ in } (.1174 \text{ m})$$

Table 3

Cavitation Performance Characteristics of Propeller 4685 Cupped

PROPELLER NUMBER 4685 PITCH RATIO = 1.000 SIGMA = 3.0																	
J	RTOUT	IRBOUT	EFFIC	KT/JZ	KQ/JJ	QC	SIGMAP	TAUC	J	RTOUT	IRBOUT	EFFIC	KT/JZ	KQ/JJ	QC	SIGMAP	TAUC
.6000	-.2876	-.5499	-.4491	.7984	-.2566	-.2464	-.6055	-.1991	.6000	-.0899	-.2818	-.5023	.7845	-.2232	-.2487	-.2077	-.1577
.6500	-.2799	-.5363	-.5226	.6413	-.1993	-.2647	-.6057	-.1778	.6500	-.0847	-.2612	-.5210	-.6725	-.1782	-.2481	-.2049	-.1561
.7000	-.2912	-.5150	-.5426	-.5157	-.1765	-.3160	-.6210	-.1645	.7000	-.0788	-.2323	-.5413	-.6758	-.1396	-.2393	-.2049	-.1561
.7500	-.2888	-.4868	-.5718	-.3762	-.1488	-.3772	-.6374	-.1310	.7500	-.0700	-.2221	-.5637	-.3960	-.1115	-.2365	-.2049	-.1561
.8000	-.1875	-.4375	-.5088	-.2506	-.1212	-.4533	-.6533	-.1159	.8000	-.0588	-.2095	-.5866	-.2772	-.0891	-.2365	-.2049	-.1561
.8500	-.1662	-.4096	-.5011	-.2051	-.0962	-.5316	-.6716	-.1011	.8500	-.0488	-.1937	-.6022	-.2074	-.0709	-.2343	-.2049	-.1561
.9000	-.1436	-.3886	-.5086	-.1582	-.0749	-.6144	-.6914	-.0877	.9000	-.0400	-.1766	-.6211	-.1561	-.0528	-.2343	-.2049	-.1561
.9500	-.1203	-.3744	-.5208	-.1142	-.0532	-.7017	-.7137	-.0750	1.0000	-.0320	-.1587	-.6400	-.1167	-.0350	-.2343	-.2049	-.1561
1.0000	-.0978	-.3638	-.5308	-.0797	-.0271	-.8021	-.7381	-.0638	1.0500	-.0250	-.1408	-.6585	-.0895	-.0263	-.2343	-.2049	-.1561
1.1000	-.0797	-.3538	-.5388	-.0497	-.0071	-.9251	-.7631	-.0538	1.1500	-.0180	-.1227	-.6768	-.0638	-.0160	-.2343	-.2049	-.1561
1.2000	-.0638	-.3438	-.5438	-.0251	-.0071	-.1.0761	-.7881	-.0438	1.2500	-.0120	-.1048	-.6950	-.0388	-.0060	-.2343	-.2049	-.1561

PROPELLER NUMBER 4685 PITCH RATIO = 1.000 SIGMA = .75																	
J	RTOUT	IRBOUT	EFFIC	KT/JZ	KQ/JJ	QC	SIGMAP	TAUC	J	RTOUT	IRBOUT	EFFIC	KT/JZ	KQ/JJ	QC	SIGMAP	TAUC
.6000	-.2862	-.3855	-.5526	-.6881	-.1484	-.3321	-.1204	-.1364	.6000	-.0899	-.2818	-.4787	.7409	-.2031	-.2169	-.2519	-.2554
.6500	-.1872	-.3879	-.5665	-.6025	-.1131	-.3114	-.1374	-.1271	.6500	-.0847	-.2612	-.4862	-.2464	-.2010	-.2169	-.2519	-.2554
.7000	-.1896	-.3863	-.5821	-.3349	-.0916	-.3114	-.1562	-.1189	.7000	-.0788	-.2421	-.5109	-.2761	-.2010	-.2169	-.2519	-.2554
.7500	-.1889	-.3828	-.5952	-.2796	-.0740	-.3106	-.1762	-.1123	.7500	-.0700	-.2233	-.5366	-.2866	-.2010	-.2169	-.2519	-.2554
.8000	-.1889	-.3774	-.6024	-.2328	-.0616	-.3097	-.1948	-.1060	.8000	-.0600	-.2048	-.5644	-.2866	-.2010	-.2169	-.2519	-.2554
.8500	-.1888	-.3718	-.6039	-.1919	-.0488	-.3088	-.2137	-.1000	.8500	-.0500	-.1866	-.5927	-.2866	-.2010	-.2169	-.2519	-.2554
.9000	-.1888	-.3658	-.6039	-.1519	-.0360	-.3079	-.2327	-.0937	.9000	-.0400	-.1684	-.6211	-.2866	-.2010	-.2169	-.2519	-.2554
.9500	-.1888	-.3598	-.6039	-.1124	-.0232	-.3070	-.2517	-.0874	1.0000	-.0300	-.1502	-.6500	-.2866	-.2010	-.2169	-.2519	-.2554
1.0000	-.1888	-.3538	-.6039	-.0728	-.0104	-.3061	-.2707	-.0813	1.0500	-.0200	-.1320	-.6785	-.2866	-.2010	-.2169	-.2519	-.2554

PROPELLER NUMBER 4685 PITCH RATIO = 1.000 SIGMA = .5

J	RTOUT	IRBOUT	EFFIC	KT/JZ	KQ/JJ	QC	SIGMAP	TAUC
.6000	-.0767	-.1413	-.4038	-.2129	-.0819	-.0157	-.0344	-.0507
.6500	-.0756	-.1765	-.4431	-.1790	-.0643	-.0147	-.0401	-.0494
.7000	-.0819	-.1873	-.4870	-.1671	-.0546	-.0154	-.0460	-.0478
.7500	-.0886	-.2016	-.5250	-.1676	-.0478	-.0164	-.0541	-.0464
.8000	-.0958	-.2070	-.5594	-.1686	-.0417	-.0163	-.0610	-.0451
.8500	-.0712	-.1668	-.5412	-.0883	-.0259	-.0144	-.0717	-.0434
.9000	-.0479	-.1543	-.4498	-.0531	-.0180	-.0114	-.0784	-.0407
.9500	-.0178	-.1866	-.2657	-.0178	-.0107	-.0080	-.0864	-.0385
1.0000	-.0155	-.1858	-.2594	-.0110	-.0044	-.0037	-.0937	-.0369

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Table 4

Cavitation Performance Characteristics of Propeller 4686

PROPELLER NUMBER 4686 PITCH RATIO = 1.000 SIGMA = 5.0																	
J	WTOUT	ISROOUT	EFFIC	RT/JZ	KQ/J3	QC	SIGMA7	TAUC	J	WTOUT	ISROOUT	EFFIC	RT/JZ	KQ/J3	QC	SIGMA7	TAUC
-5.000	-2.661	-4.114	.5236	.8155	.2473	.3387	.1842	.1878	-5.000	-2.242	-3.519	.5889	.7412	.2355	.3348	.1785	.1528
-6.000	-2.228	-3.824	.5559	.8191	.1773	.3379	.1842	.1508	-6.000	-2.125	-3.743	.5764	.5002	.1751	.3325	.2077	.1430
-7.000	-1.771	-3.528	.5888	.8731	.1283	.3269	.1607	.1329	-7.000	-1.728	-3.197	.5925	.4597	.1242	.3299	.2408	.1292
-8.000	-1.317	-3.234	.6326	.8816	.0936	.3132	.1163	.1163	-8.000	-1.597	-2.856	.6297	.2678	.0927	.3288	.2798	.1135
-9.000	-1.117	-2.968	.6591	.8858	.0688	.3008	.0808	.1000	-9.000	-1.507	-2.656	.6591	.2078	.0694	.3286	.3164	.0974
-10.000	-1.091	-2.768	.6811	.8859	.0569	.2882	.0533	.0881	-10.000	-1.490	-2.533	.6807	.1508	.0564	.3287	.3507	.0866
-11.000	-1.087	-2.639	.6949	.8878	.0478	.2764	.0414	.0757	-11.000	-1.488	-2.423	.7026	.1198	.0478	.3288	.3811	.0784
-12.000	-1.083	-2.538	.7065	.8879	.0420	.2652	.0362	.0622	-12.000	-1.489	-2.323	.7168	.0968	.0420	.3289	.4081	.0715
-13.000	-1.078	-2.452	.7167	.8879	.0378	.2544	.0312	.0487	-13.000	-1.489	-2.233	.7244	.0788	.0378	.3290	.4321	.0658
-14.000	-1.073	-2.378	.7256	.8878	.0340	.2440	.0268	.0352	-14.000	-1.488	-2.152	.7316	.0638	.0340	.3291	.4531	.0611
-15.000	-1.068	-2.314	.7332	.8877	.0308	.2340	.0228	.0228	-15.000	-1.487	-2.078	.7382	.0508	.0308	.3292	.4711	.0574
-16.000	-1.063	-2.258	.7396	.8876	.0278	.2244	.0198	.0198	-16.000	-1.486	-2.012	.7444	.0388	.0278	.3293	.4871	.0544
-17.000	-1.058	-2.208	.7448	.8875	.0250	.2152	.0168	.0168	-17.000	-1.485	-1.952	.7502	.0278	.0250	.3294	.5011	.0518
-18.000	-1.053	-2.164	.7498	.8874	.0224	.2064	.0138	.0138	-18.000	-1.484	-1.898	.7556	.0178	.0224	.3295	.5131	.0494
-19.000	-1.048	-2.124	.7546	.8873	.0198	.1980	.0108	.0108	-19.000	-1.483	-1.848	.7606	.0088	.0198	.3296	.5241	.0470
-20.000	-1.043	-2.088	.7592	.8872	.0174	.1900	.0078	.0078	-20.000	-1.482	-1.802	.7652	.0008	.0174	.3297	.5341	.0446
-21.000	-1.038	-2.056	.7636	.8871	.0150	.1824	.0048	.0048	-21.000	-1.481	-1.760	.7696	.0000	.0150	.3298	.5431	.0422
-22.000	-1.033	-2.028	.7678	.8870	.0126	.1752	.0018	.0018	-22.000	-1.480	-1.722	.7738	.0000	.0126	.3299	.5511	.0398
-23.000	-1.028	-2.004	.7718	.8869	.0102	.1684	.0000	.0000	-23.000	-1.479	-1.688	.7778	.0000	.0102	.3300	.5581	.0374
-24.000	-1.023	-1.984	.7756	.8868	.0078	.1620	.0000	.0000	-24.000	-1.478	-1.658	.7816	.0000	.0078	.3301	.5641	.0350
-25.000	-1.018	-1.968	.7792	.8867	.0054	.1560	.0000	.0000	-25.000	-1.477	-1.632	.7852	.0000	.0054	.3302	.5691	.0326
-26.000	-1.013	-1.956	.7826	.8866	.0030	.1504	.0000	.0000	-26.000	-1.476	-1.610	.7886	.0000	.0030	.3303	.5731	.0302
-27.000	-1.008	-1.948	.7858	.8865	.0006	.1452	.0000	.0000	-27.000	-1.475	-1.592	.7918	.0000	.0006	.3304	.5771	.0278
-28.000	-1.003	-1.944	.7888	.8864	.0000	.1404	.0000	.0000	-28.000	-1.474	-1.578	.7948	.0000	.0000	.3305	.5811	.0254
-29.000	-1.000	-1.944	.7916	.8863	.0000	.1360	.0000	.0000	-29.000	-1.473	-1.568	.7976	.0000	.0000	.3306	.5851	.0230
-30.000	-1.000	-1.948	.7942	.8862	.0000	.1320	.0000	.0000	-30.000	-1.472	-1.562	.8002	.0000	.0000	.3307	.5891	.0206
-31.000	-1.000	-1.956	.7966	.8861	.0000	.1284	.0000	.0000	-31.000	-1.471	-1.560	.8026	.0000	.0000	.3308	.5931	.0182
-32.000	-1.000	-1.968	.7988	.8860	.0000	.1252	.0000	.0000	-32.000	-1.470	-1.562	.8048	.0000	.0000	.3309	.5971	.0158
-33.000	-1.000	-1.984	.8008	.8859	.0000	.1224	.0000	.0000	-33.000	-1.469	-1.568	.8068	.0000	.0000	.3310	.6011	.0134
-34.000	-1.000	-1.998	.8026	.8858	.0000	.1200	.0000	.0000	-34.000	-1.468	-1.578	.8086	.0000	.0000	.3311	.6051	.0110
-35.000	-1.000	-2.018	.8042	.8857	.0000	.1180	.0000	.0000	-35.000	-1.467	-1.592	.8102	.0000	.0000	.3312	.6091	.0086
-36.000	-1.000	-2.042	.8056	.8856	.0000	.1164	.0000	.0000	-36.000	-1.466	-1.610	.8116	.0000	.0000	.3313	.6131	.0062
-37.000	-1.000	-2.068	.8068	.8855	.0000	.1152	.0000	.0000	-37.000	-1.465	-1.632	.8128	.0000	.0000	.3314	.6171	.0038
-38.000	-1.000	-2.096	.8078	.8854	.0000	.1144	.0000	.0000	-38.000	-1.464	-1.658	.8138	.0000	.0000	.3315	.6211	.0014
-39.000	-1.000	-2.126	.8086	.8853	.0000	.1140	.0000	.0000	-39.000	-1.463	-1.688	.8146	.0000	.0000	.3316	.6251	.0000
-40.000	-1.000	-2.158	.8092	.8852	.0000	.1140	.0000	.0000	-40.000	-1.462	-1.722	.8152	.0000	.0000	.3317	.6291	.0000
-41.000	-1.000	-2.192	.8096	.8851	.0000	.1144	.0000	.0000	-41.000	-1.461	-1.760	.8156	.0000	.0000	.3318	.6331	.0000
-42.000	-1.000	-2.228	.8098	.8850	.0000	.1152	.0000	.0000	-42.000	-1.460	-1.802	.8158	.0000	.0000	.3319	.6371	.0000
-43.000	-1.000	-2.266	.8098	.8849	.0000	.1164	.0000	.0000	-43.000	-1.459	-1.848	.8158	.0000	.0000	.3320	.6411	.0000
-44.000	-1.000	-2.306	.8096	.8848	.0000	.1180	.0000	.0000	-44.000	-1.458	-1.900	.8156	.0000	.0000	.3321	.6451	.0000
-45.000	-1.000	-2.348	.8092	.8847	.0000	.1200	.0000	.0000	-45.000	-1.457	-1.958	.8152	.0000	.0000	.3322	.6491	.0000
-46.000	-1.000	-2.392	.8086	.8846	.0000	.1224	.0000	.0000	-46.000	-1.456	-2.022	.8146	.0000	.0000	.3323	.6531	.0000
-47.000	-1.000	-2.438	.8078	.8845	.0000	.1252	.0000	.0000	-47.000	-1.455	-2.092	.8138	.0000	.0000	.3324	.6571	.0000
-48.000	-1.000	-2.486	.8068	.8844	.0000	.1284	.0000	.0000	-48.000	-1.454	-2.168	.8128	.0000	.0000	.3325	.6611	.0000
-49.000	-1.000	-2.536	.8056	.8843	.0000	.1320	.0000	.0000	-49.000	-1.453	-2.250	.8116	.0000	.0000	.3326	.6651	.0000
-50.000	-1.000	-2.588	.8042	.8842	.0000	.1360	.0000	.0000	-50.000	-1.452	-2.338	.8102	.0000	.0000	.3327	.6691	.0000
-51.000	-1.000	-2.642	.8026	.8841	.0000	.1404	.0000	.0000	-51.000	-1.451	-2.432	.8086	.0000	.0000	.3328	.6731	.0000
-52.000	-1.000	-2.698	.8008	.8840	.0000	.1452	.0000	.0000	-52.000	-1.450	-2.532	.8068	.0000	.0000	.3329	.6771	.0000
-53.000	-1.000	-2.756	.7988	.8839	.0000	.1504	.0000	.0000	-53.000	-1.449	-2.638	.8048	.0000	.0000	.3330	.6811	.0000
-54.000	-1.000	-2.816	.7966	.8838	.0000	.1560	.0000	.0000	-54.000	-1.448	-2.750	.8026	.0000	.0000	.3331	.6851	.0000
-55.000	-1.000	-2.878	.7942	.8837	.0000	.1620	.0000	.0000	-55.000	-1.447	-2.868	.8002	.0000	.0000	.3332	.6891	.0000
-56.000	-1.000	-2.942	.7916	.8836	.0000	.1684	.0000	.0000	-56.000	-1.446	-2.992	.7976	.0000	.0000	.3333	.6931	.0000
-57.000	-1.000	-3.008	.7888	.8835	.0000	.1752	.0000	.0000	-57.000	-1.445	-3.122	.7948	.0000	.0000	.3334	.6971	.0000
-58.000	-1.000	-3.076	.7858	.8834	.0000	.1824	.0000	.0000	-58.000	-1.444	-3.258	.7918	.0000	.0000	.3335	.7011	.0000
-59.000	-1.000	-3.146	.7826	.8833	.0000	.1900	.0000	.0000	-59.000	-1.443	-3.400	.7886	.0000	.0000	.3336	.7051	.0000
-60.000	-1.000	-3.218	.7792	.8832	.0000	.1980	.0000	.0000	-60.000	-1.442	-3.548	.7852	.0000	.0000	.3337	.7091	.0000
-61.000	-1.000	-3.292	.7756	.8831	.0000	.2064	.0000	.0000	-61.000	-1.441	-3.702	.7816	.0000	.0000	.3338	.7131	.0000
-62.000	-1.000	-3.368	.7718	.8830	.0000	.2152	.0000	.0000	-62.000	-1.440	-3.862	.7778	.0000	.0000	.3339	.7171	.0000
-63.000	-1.000	-3.446	.7678	.8829	.0000	.2244	.0000	.0000	-63.000	-1.439	-4.028	.7738	.0000	.0000	.3340	.7211	.0000
-64.000	-1.000	-3.526	.7636	.8828	.0000	.2340	.0000	.0000	-64.000	-1.438	-4.200	.7696	.0000	.0000	.3341	.7251	.0000
-65.000	-1.000	-3.608	.7592	.8827	.0000	.2440	.0000	.0000	-65.000	-1.437	-4.378	.7652	.0000	.0000	.3342	.7291	.0000
-66.000	-1.000	-3.692	.7546	.8826	.0000	.2544	.0000	.0000	-66.000	-1.436	-4.562	.7606	.0000	.0000	.3343	.7331	.0000
-67.000	-1.000	-3.778	.7498	.8825	.0000	.2652	.0000	.0000	-67.000	-1.435	-4.752	.7556	.0000	.0000	.3344	.7371	.0000
-68.000	-1.000	-3.866	.7448	.8824	.0000	.2764	.0000	.0000	-68.000	-1.434	-4.948	.7502	.0000	.0000	.3345	.7411	.0000
-69.000	-1.000	-3.956	.7396	.8823	.0000	.2880	.0000	.0000	-69.000	-1.433	-5.150	.7444	.0000	.0000	.3346	.7451	.0000
-70.000	-1.000	-4.048	.7342	.8822	.0000	.3000	.0000	.0000	-70.000	-1.432	-5.358	.7386	.0000	.0000	.3347	.7491	.0000
-71.000	-1.000	-4.142	.7286	.8821	.0000	.3124	.0000	.0000	-71.000	-1.431	-5.572	.7326	.0000	.0000	.3348	.7531	.0000
-72.000	-1.000	-4.238	.7228	.8820	.0000	.3252	.0000	.0000	-72.000	-1.430	-5.792	.7264	.0000	.0000	.3349	.7571	.0000
-73.000	-1.000	-4.336	.7168	.8819	.0000	.3384	.0000	.0000	-73.000	-1.429	-6.018	.7202	.0000	.0000	.3350	.761	

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

Table 5
Cavitation Performance Characteristics of Propeller 4686 Cupped

PROPELLER NUMBER 4686 PITCH RATIO = 1.000 SIGMA = 5.0																	
J	KTOUT	IBROOUT	EFFIC	KT/J2	KQ/J3	QC	SIGMA7	TAUC	J	KTOUT	IBROOUT	EFFIC	KT/J2	KQ/J3	QC	SIGMA7	TAUC
-5500	-2650	-4629	-5011	-0759	-2782	-0402	-3412	-1003	-5500	-2301	-4284	-4866	-7872	-2875	-3172	-1785	-1621
-6000	-2432	-4263	-5323	-0755	-2829	-0373	-3012	-1003	-6000	-2246	-4192	-5229	-6376	-1941	-3168	-2077	-1565
-6500	-2205	-4050	-5631	-0749	-2876	-0343	-2612	-1003	-6500	-2190	-4100	-5584	-6978	-1692	-3166	-2489	-1427
-7000	-1978	-3738	-5937	-0743	-2923	-0313	-2212	-1003	-7000	-2134	-4008	-5942	-7590	-1423	-3164	-2901	-1289
-7500	-1751	-3426	-6243	-0737	-2970	-0283	-1812	-1003	-7500	-2078	-3916	-6300	-8202	-1154	-3162	-3313	-1151
-8000	-1524	-3114	-6549	-0731	-3017	-0253	-1412	-1003	-8000	-2022	-3824	-6658	-8814	-883	-3160	-3725	-1013
-8500	-1297	-2802	-6855	-0725	-3064	-0223	-1012	-1003	-8500	-1966	-3732	-7016	-9426	-614	-3158	-4137	-875
-9000	-1070	-2490	-7161	-0719	-3111	-0193	-612	-1003	-9000	-1910	-3640	-7418	-10038	-345	-3156	-4549	-737
-9500	-843	-2178	-7467	-0713	-3158	-0163	-212	-1003	-9500	-1854	-3548	-7820	-10650	-76	-3154	-4961	-599
-10000	-616	-1866	-7773	-0707	-3205	-0133	182	-1003	-10000	-1798	-3456	-8222	-11262	103	-3152	-5373	-461
-10500	-389	-1554	-8079	-0701	-3252	-0103	782	-1003	-10500	-1742	-3364	-8624	-11874	414	-3150	-5785	-323
-11000	-162	-1242	-8385	-0695	-3299	-0073	1782	-1003	-11000	-1686	-3272	-9026	-12526	825	-3148	-6197	-185
-11500	75	-930	-8691	-0689	-3346	-0043	2742	-1003	-11500	-1630	-3180	-9428	-13178	1236	-3146	-6609	-47
-12000	282	-618	-9000	-0683	-3393	-0013	3702	-1003	-12000	-1574	-3088	-9830	-13830	1647	-3144	-7021	91
-12500	569	-306	-9308	-0677	-3440	0017	4662	-1003	-12500	-1518	-2996	-10232	-14482	2058	-3142	-7433	253
-13000	856	006	-9616	-0671	-3487	0047	5622	-1003	-13000	-1462	-2904	-10634	-15134	2469	-3140	-7845	615
-13500	1143	314	-9924	-0665	-3534	0077	6582	-1003	-13500	-1406	-2812	-11036	-15786	2880	-3138	-8257	1277
-14000	1430	622	-10232	-0659	-3581	0107	7542	-1003	-14000	-1350	-2720	-11438	-16438	3291	-3136	-8669	1939
-14500	1717	930	-10540	-0653	-3628	0137	8502	-1003	-14500	-1294	-2628	-11840	-17090	3702	-3134	-9081	2601
-15000	2004	1238	-10848	-0647	-3675	0167	9462	-1003	-15000	-1238	-2536	-12242	-17742	4113	-3132	-9493	3263
-15500	2291	1546	-11156	-0641	-3722	0197	10422	-1003	-15500	-1182	-2444	-12644	-18394	4524	-3130	-9905	3925
-16000	2578	1854	-11464	-0635	-3769	0227	11382	-1003	-16000	-1126	-2352	-13046	-19046	4935	-3128	-10317	4587
-16500	2865	2162	-11772	-0629	-3816	0257	12342	-1003	-16500	-1070	-2260	-13448	-19698	5346	-3126	-10729	5249
-17000	3152	2470	-12080	-0623	-3863	0287	13302	-1003	-17000	-1014	-2168	-13850	-20350	5757	-3124	-11141	5911
-17500	3439	2778	-12388	-0617	-3910	0317	14262	-1003	-17500	-958	-2076	-14252	-21002	6168	-3122	-11553	6573
-18000	3726	3086	-12696	-0611	-3957	0347	15222	-1003	-18000	-902	-1984	-14654	-21654	6579	-3120	-11965	7235
-18500	4013	3394	-13004	-0605	-4004	0377	16182	-1003	-18500	-846	-1892	-15056	-22306	6990	-3118	-12377	7897
-19000	4300	3702	-13312	-0599	-4051	0407	17142	-1003	-19000	-790	-1800	-15458	-22958	7401	-3116	-12789	8559
-19500	4587	4010	-13620	-0593	-4098	0437	18102	-1003	-19500	-734	-1708	-15860	-23610	7812	-3114	-13201	9221
-20000	4874	4318	-13928	-0587	-4145	0467	19062	-1003	-20000	-678	-1616	-16262	-24262	8223	-3112	-13613	9883
-20500	5161	4626	-14236	-0581	-4192	0497	20022	-1003	-20500	-622	-1524	-16664	-24914	8634	-3110	-14025	10545
-21000	5448	4934	-14544	-0575	-4239	0527	20982	-1003	-21000	-566	-1432	-17066	-25566	9045	-3108	-14437	11207
-21500	5735	5242	-14852	-0569	-4286	0557	21942	-1003	-21500	-510	-1340	-17468	-26218	9456	-3106	-14849	11869
-22000	6022	5550	-15160	-0563	-4333	0587	22902	-1003	-22000	-454	-1248	-17870	-26870	9867	-3104	-15261	12531
-22500	6309	5858	-15468	-0557	-4380	0617	23862	-1003	-22500	-398	-1156	-18272	-27522	10278	-3102	-15673	13193
-23000	6596	6166	-15776	-0551	-4427	0647	24822	-1003	-23000	-342	-1064	-18674	-28174	10689	-3100	-16085	13855
-23500	6883	6474	-16084	-0545	-4474	0677	25782	-1003	-23500	-286	-972	-19076	-28826	11100	-3098	-16497	14517
-24000	7170	6782	-16392	-0539	-4521	0707	26742	-1003	-24000	-230	-880	-19478	-29478	11511	-3096	-16909	15179
-24500	7457	7090	-16700	-0533	-4568	0737	27702	-1003	-24500	-174	-788	-19880	-30130	11922	-3094	-17321	15841
-25000	7744	7398	-17008	-0527	-4615	0767	28662	-1003	-25000	-118	-696	-20282	-30782	12333	-3092	-17733	16503
-25500	8031	7706	-17316	-0521	-4662	0797	29622	-1003	-25500	-62	-604	-20684	-31434	12744	-3090	-18145	17165
-26000	8318	8014	-17624	-0515	-4709	0827	30582	-1003	-26000	-6	-512	-21086	-32086	13155	-3088	-18557	17827
-26500	8605	8322	-17932	-0509	-4756	0857	31542	-1003	-26500	50	-420	-21488	-32738	13566	-3086	-18969	18489
-27000	8892	8630	-18240	-0503	-4803	0887	32502	-1003	-27000	94	-328	-21890	-33390	13977	-3084	-19381	19151
-27500	9179	8938	-18548	-0497	-4850	0917	33462	-1003	-27500	138	-236	-22292	-34042	14388	-3082	-19793	19813
-28000	9466	9246	-18856	-0491	-4897	0947	34422	-1003	-28000	182	-144	-22694	-34694	14799	-3080	-20205	20475
-28500	9753	9554	-19164	-0485	-4944	0977	35382	-1003	-28500	226	-52	-23096	-35346	15210	-3078	-20617	21137
-29000	10040	9862	-19472	-0479	-4991	1007	36342	-1003	-29000	270	58	-23498	-36000	15621	-3076	-21029	21799
-29500	10327	10170	-19780	-0473	-5038	1037	37302	-1003	-29500	314	166	-23900	-36652	16032	-3074	-21441	22461
-30000	10614	10478	-20088	-0467	-5085	1067	38262	-1003	-30000	358	274	-24302	-37304	16443	-3072	-21853	23123
-30500	10901	10786	-20396	-0461	-5132	1097	39222	-1003	-30500	402	382	-24704	-37956	16854	-3070	-22265	23785
-31000	11188	11094	-20704	-0455	-5179	1127	40182	-1003	-31000	446	490	-25106	-38608	17265	-3068	-22677	24447
-31500	11475	11402	-21012	-0449	-5226	1157	41142	-1003	-31500	490	598	-25508	-39260	17676	-3066	-23089	25109
-32000	11762	11710	-21320	-0443	-5273	1187	42102	-1003	-32000	534	706	-25910	-39912	18087	-3064	-23501	25771
-32500	12049	12018	-21628	-0437	-5320	1217	43062	-1003	-32500	578	814	-26312	-40564	18498	-3062	-23913	26433
-33000	12336	12326	-21936	-0431	-5367	1247	44022	-1003	-33000	622	922	-26714	-41216	18909	-3060	-24325	27095
-33500	12623	12634	-22244	-0425	-5414	1277	44982	-1003	-33500	666	1030	-27116	-41868	19320	-3058	-24737	27757
-34000	12910	12942	-22552	-0419	-5461	1307	45942	-1003	-34000	710	1138	-27518	-42520	19731	-3056	-25149	28419
-34500	13197	13250	-22860	-0413	-5508	1337	46902	-1003	-34500	754	1246	-27920	-43172	20142	-3054	-25561	29081
-35000	13484	13558	-23168	-0407	-5555	1367	47862	-1003	-35000	798	1354	-28322	-43824	20553	-3052	-25973	29743
-35500	13771	13866	-23476	-0401	-5602	1397	48822	-1003	-35500	842	1462	-28724	-44476	20964	-3050	-26385	30405
-36000	14058	14174	-23784	-0395	-5649	1427	49782	-1003	-36000	886	1570	-29126	-45128	21375	-3048	-26797	31067
-36500	14345	14482	-24092	-0389	-5696	1457	50742	-1003	-36500	930	1678	-29528	-45780	21786	-3046	-27209	31729
-37000	14632	14790	-24400	-0383	-5743	1487	51702	-1003	-37000	974	1786	-29930	-46432	22197	-3044	-27621	32391
-37500	14919	15098	-24708	-0377	-5790	1517	52662	-1003	-37500	1018	1894	-30332	-47084	22608	-3042	-28033	33053
-38000	15206	15406	-25016	-0371	-5837	1547	53622	-1003	-38000	1062	2002	-30734	-47736	23019	-3040	-28445	33715
-38500	15493	15714	-25324	-0365	-5884	1577	54582	-1003	-38500	1106	2110	-31136	-48388	23430	-3038	-28857	34377
-39000	15780	16022	-25632	-0359	-5931	1607	55542	-1003	-39000	1150	2218	-31538	-49040	23841	-3036	-29269	35039
-39500	16067	16330	-25940	-0353	-5978	1637	56502	-1003	-39500	1194	2326	-31940	-49692	24252	-3034	-29681	35701
-40000	16354	16638	-26248	-0347	-6025	1667	57462	-1003	-40000	1238	243						

Table 6

Cavitation Performance Characteristics of Propeller 4687

PROPELLER NUMBER 4687 PITCH RATIO = 1.100 SIGMA = 5.0																	
J	RTOUT	IRGOUT	EFFIC	KT/J2	KQ/J3	QC	SIGMA7	TAUC	J	RTOUT	IRGOUT	EFFIC	KT/J2	KQ/J3	QC	SIGMA7	TAUC
6.000	-2.810	-5.105	0.882	0.785	0.243	0.668	0.615	0.193	6.000	-2.600	-5.211	0.887	0.788	0.242	0.667	0.614	0.193
6.500	-2.641	-4.916	0.823	0.851	0.186	0.410	0.643	0.173	6.500	-2.504	-5.554	0.538	0.521	0.192	0.411	0.642	0.174
7.000	-2.518	-4.613	0.594	0.714	0.135	0.391	0.332	0.154	7.000	-2.408	-5.704	0.521	0.495	0.172	0.389	0.331	0.154
7.500	-2.381	-4.310	0.365	0.577	0.084	0.372	0.078	0.135	7.500	-2.197	-5.854	0.884	0.480	0.174	0.388	0.314	0.133
8.000	-2.244	-4.007	0.136	0.440	0.033	0.353	0.022	0.116	8.000	-1.986	-5.999	0.867	0.463	0.176	0.387	0.297	0.115
8.500	-2.107	-3.704	0.239	0.303	0.053	0.334	0.067	0.097	8.500	-1.881	-6.149	0.527	0.446	0.178	0.386	0.280	0.098
9.000	-1.970	-3.401	0.291	0.166	0.044	0.315	0.011	0.078	9.000	-1.672	-6.299	0.510	0.429	0.180	0.385	0.263	0.081
9.500	-1.833	-3.098	0.243	0.029	0.035	0.296	0.055	0.059	9.500	-1.467	-6.449	0.527	0.412	0.182	0.384	0.246	0.064
1.0000	-0.894	-2.248	0.943	0.859	0.239	0.178	0.932	0.250	1.0000	-0.800	-2.778	0.680	0.829	0.223	0.177	0.931	0.248
1.1000	-0.825	-2.098	0.884	0.792	0.180	0.159	0.913	0.231	1.1000	-0.741	-2.928	0.614	0.762	0.181	0.158	0.912	0.229
1.1500	-0.825	-1.948	0.825	0.725	0.181	0.140	0.894	0.212	1.1500	-0.682	-3.078	0.548	0.695	0.182	0.159	0.893	0.210
1.1500	-0.825	-1.798	0.766	0.658	0.182	0.121	0.875	0.193	1.1500	-0.623	-3.228	0.482	0.628	0.183	0.158	0.874	0.191
1.1500	-0.825	-1.648	0.707	0.591	0.183	0.102	0.856	0.174	1.1500	-0.564	-3.378	0.416	0.561	0.184	0.157	0.855	0.172
1.1500	-0.825	-1.498	0.648	0.524	0.184	0.083	0.837	0.155	1.1500	-0.505	-3.528	0.350	0.494	0.185	0.156	0.836	0.153

PROPELLER NUMBER 4687 PITCH RATIO = 1.100 SIGMA = 7.5																	
J	RTOUT	IRGOUT	EFFIC	KT/J2	KQ/J3	QC	SIGMA7	TAUC	J	RTOUT	IRGOUT	EFFIC	KT/J2	KQ/J3	QC	SIGMA7	TAUC
6.000	-2.650	-5.050	0.879	0.788	0.243	0.668	0.615	0.193	6.000	-2.440	-5.156	0.882	0.791	0.242	0.667	0.614	0.193
6.500	-2.481	-4.861	0.820	0.851	0.186	0.410	0.643	0.173	6.500	-2.344	-5.500	0.539	0.524	0.192	0.411	0.642	0.174
7.000	-2.358	-4.558	0.591	0.714	0.135	0.391	0.332	0.154	7.000	-2.252	-5.650	0.524	0.498	0.172	0.389	0.331	0.154
7.500	-2.221	-4.255	0.362	0.577	0.084	0.372	0.078	0.135	7.500	-2.041	-5.800	0.887	0.483	0.174	0.388	0.314	0.133
8.000	-2.084	-3.952	0.133	0.440	0.033	0.353	0.022	0.116	8.000	-1.830	-5.950	0.870	0.466	0.176	0.387	0.297	0.115
8.500	-1.947	-3.649	0.236	0.303	0.053	0.334	0.067	0.097	8.500	-1.725	-6.100	0.528	0.449	0.178	0.386	0.280	0.098
9.000	-1.810	-3.346	0.288	0.166	0.044	0.315	0.011	0.078	9.000	-1.514	-6.250	0.511	0.432	0.180	0.385	0.263	0.081
9.500	-1.673	-3.043	0.240	0.029	0.035	0.296	0.055	0.059	9.500	-1.409	-6.400	0.528	0.415	0.182	0.384	0.246	0.064
1.0000	-0.755	-2.201	0.946	0.862	0.239	0.178	0.932	0.250	1.0000	-0.750	-2.751	0.691	0.832	0.223	0.177	0.931	0.249
1.1000	-0.686	-2.051	0.887	0.795	0.180	0.159	0.913	0.231	1.1000	-0.691	-2.901	0.625	0.765	0.181	0.158	0.912	0.230
1.1500	-0.686	-1.901	0.828	0.728	0.181	0.140	0.894	0.212	1.1500	-0.632	-3.051	0.559	0.698	0.182	0.157	0.893	0.211
1.1500	-0.686	-1.751	0.769	0.661	0.182	0.121	0.875	0.193	1.1500	-0.573	-3.201	0.493	0.631	0.183	0.156	0.874	0.192
1.1500	-0.686	-1.601	0.710	0.594	0.183	0.102	0.856	0.174	1.1500	-0.514	-3.351	0.427	0.564	0.184	0.155	0.855	0.173
1.1500	-0.686	-1.451	0.651	0.527	0.184	0.083	0.837	0.155	1.1500	-0.455	-3.501	0.361	0.497	0.185	0.154	0.836	0.154

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION.

Table 7
Cavitation Performance Characteristics of Propeller 4687 Cupped

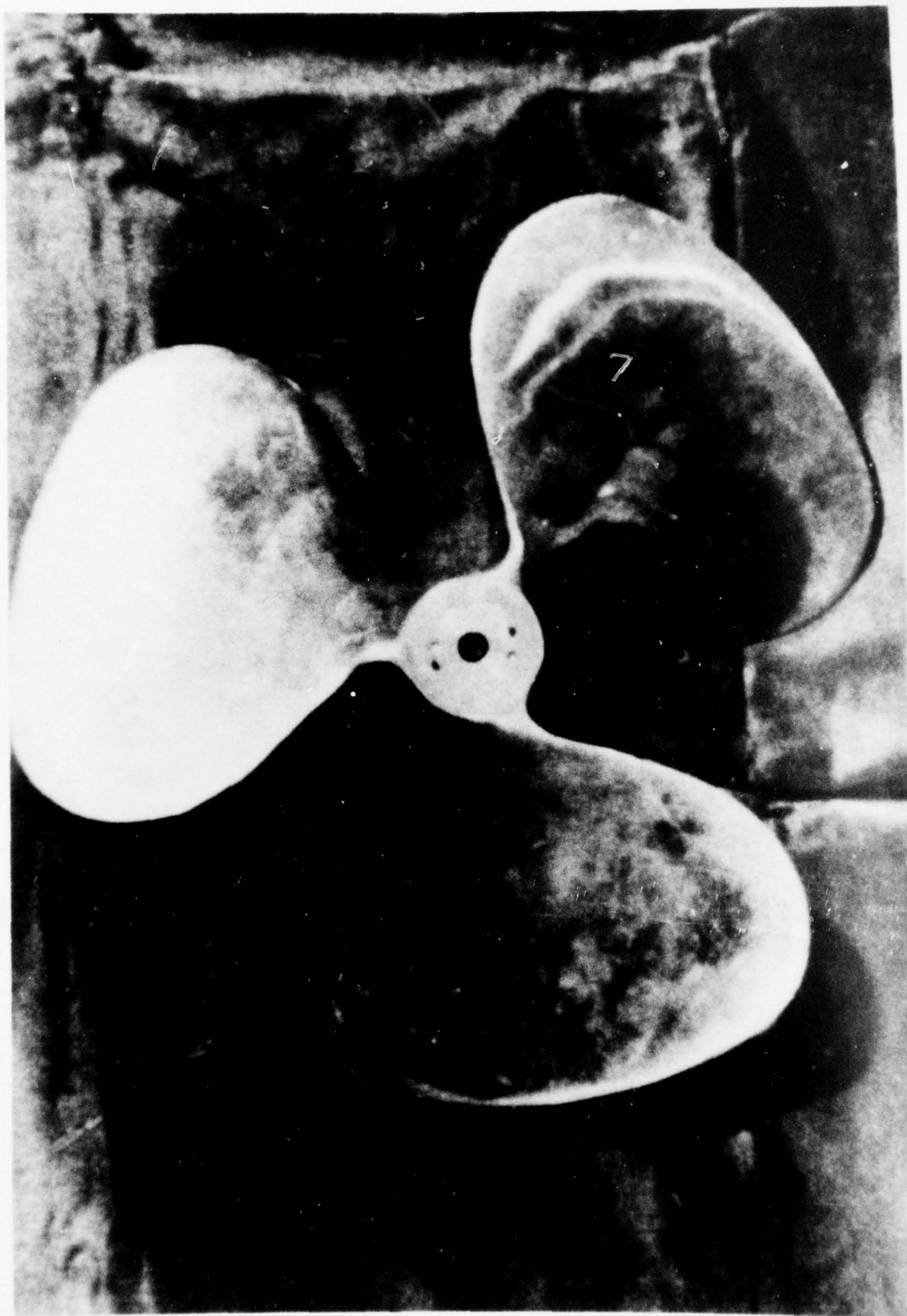
PROPELLER NUMBER #4687 PITCH RATIO = 1.100 SIGMA = 3.8										
J	KTOUT	18QOUT	EFFIC	KT/J2	KQ/J3	QC	SIGM7	TAUC	J	TAUC
0.600	-3148	-6212	-4839	-8744	-2876	0.539	0.815	-2143	0.600	-2143
0.700	-2996	-5836	-5237	-8096	-2126	0.501	0.407	-1989	0.700	-1989
0.800	-2847	-5488	-5659	-7448	-1226	0.423	0.135	-1837	0.800	-1837
0.900	-2701	-5179	-6086	-6800	0.348	0.378	0.778	-1684	0.900	-1684
1.000	-2557	-4927	-6508	-6152	0.273	0.633	1.783	-1531	1.000	-1531
1.100	-2414	-4692	-6925	-5504	0.200	0.888	2.788	-1378	1.100	-1378
1.200	-2271	-4474	-7337	-4856	0.128	1.143	3.793	-1224	1.200	-1224
1.300	-2128	-4274	-7744	-4208	0.058	1.398	4.798	-1070	1.300	-1070
1.400	-2000	-4092	-8146	-3560	0.000	1.653	5.793	-916	1.400	-916
1.500	-1881	-3927	-8543	-2912	0.000	1.908	6.788	-762	1.500	-762
1.600	-1771	-3779	-8935	-2264	0.000	2.163	7.783	-608	1.600	-608
1.700	-1668	-3646	-9322	-1616	0.000	2.418	8.778	-454	1.700	-454
1.800	-1571	-3527	-9704	-968	0.000	2.673	9.773	-300	1.800	-300
1.900	-1479	-3422	-10081	-320	0.000	2.928	10.768	-146	1.900	-146
2.000	-1392	-3330	-10453	320	0.000	3.183	11.763	10	2.000	10
2.100	-1310	-3250	-10820	972	0.000	3.438	12.758	154	2.100	154
2.200	-1233	-3181	-11182	1624	0.000	3.693	13.753	300	2.200	300
2.300	-1161	-3123	-11539	2276	0.000	3.948	14.748	446	2.300	446
2.400	-1094	-3075	-11891	2928	0.000	4.203	15.743	592	2.400	592
2.500	-1032	-3036	-12238	3580	0.000	4.458	16.738	738	2.500	738
2.600	-974	-3005	-12580	4232	0.000	4.713	17.733	884	2.600	884
2.700	-920	-2982	-12917	4884	0.000	4.968	18.728	1030	2.700	1030
2.800	-869	-2966	-13249	5536	0.000	5.223	19.723	1176	2.800	1176
2.900	-821	-2956	-13576	6188	0.000	5.478	20.718	1322	2.900	1322
3.000	-775	-2952	-13900	6840	0.000	5.733	21.713	1468	3.000	1468
3.100	-731	-2954	-14220	7492	0.000	5.988	22.708	1614	3.100	1614
3.200	-688	-2961	-14537	8144	0.000	6.243	23.703	1760	3.200	1760
3.300	-646	-2973	-14850	8796	0.000	6.498	24.698	1906	3.300	1906
3.400	-605	-2990	-15159	9448	0.000	6.753	25.693	2052	3.400	2052
3.500	-565	-3012	-15464	10100	0.000	7.008	26.688	2198	3.500	2198
3.600	-526	-3039	-15765	10752	0.000	7.263	27.683	2344	3.600	2344
3.700	-488	-3071	-16062	11404	0.000	7.518	28.678	2490	3.700	2490
3.800	-451	-3108	-16355	12056	0.000	7.773	29.673	2636	3.800	2636
3.900	-415	-3150	-16644	12708	0.000	8.028	30.668	2782	3.900	2782
4.000	-380	-3197	-16929	13360	0.000	8.283	31.663	2928	4.000	2928
4.100	-346	-3249	-17210	14012	0.000	8.538	32.658	3074	4.100	3074
4.200	-313	-3306	-17487	14664	0.000	8.793	33.653	3220	4.200	3220
4.300	-281	-3368	-17760	15316	0.000	9.048	34.648	3366	4.300	3366
4.400	-250	-3435	-18029	15968	0.000	9.303	35.643	3512	4.400	3512
4.500	-220	-3507	-18294	16620	0.000	9.558	36.638	3658	4.500	3658
4.600	-191	-3584	-18555	17272	0.000	9.813	37.633	3804	4.600	3804
4.700	-163	-3666	-18812	17924	0.000	10.068	38.628	3950	4.700	3950
4.800	-136	-3753	-19065	18576	0.000	10.323	39.623	4096	4.800	4096
4.900	-110	-3845	-19314	19228	0.000	10.578	40.618	4242	4.900	4242
5.000	-85	-3942	-19559	19880	0.000	10.833	41.613	4388	5.000	4388
5.100	-61	-4044	-19800	20532	0.000	11.088	42.608	4534	5.100	4534
5.200	-38	-4151	-20037	21184	0.000	11.343	43.603	4680	5.200	4680
5.300	-16	-4263	-20270	21836	0.000	11.598	44.598	4826	5.300	4826
5.400	7	-4380	-20500	22488	0.000	11.853	45.593	4972	5.400	4972
5.500	28	-4502	-20727	23140	0.000	12.108	46.588	5118	5.500	5118
5.600	59	-4629	-20951	23792	0.000	12.363	47.583	5264	5.600	5264
5.700	90	-4761	-21172	24444	0.000	12.618	48.578	5410	5.700	5410
5.800	121	-4898	-21390	25096	0.000	12.873	49.573	5556	5.800	5556
5.900	152	-5040	-21605	25748	0.000	13.128	50.568	5702	5.900	5702
6.000	183	-5187	-21817	26400	0.000	13.383	51.563	5848	6.000	5848
6.100	214	-5339	-22026	27052	0.000	13.638	52.558	5994	6.100	5994
6.200	245	-5496	-22232	27704	0.000	13.893	53.553	6140	6.200	6140
6.300	276	-5658	-22435	28356	0.000	14.148	54.548	6286	6.300	6286
6.400	307	-5825	-22635	29008	0.000	14.403	55.543	6432	6.400	6432
6.500	338	-5997	-22832	29660	0.000	14.658	56.538	6578	6.500	6578
6.600	369	-6174	-23026	30312	0.000	14.913	57.533	6724	6.600	6724
6.700	400	-6356	-23217	30964	0.000	15.168	58.528	6870	6.700	6870
6.800	431	-6543	-23405	31616	0.000	15.423	59.523	7016	6.800	7016
6.900	462	-6735	-23590	32268	0.000	15.678	60.518	7162	6.900	7162
7.000	493	-6932	-23772	32920	0.000	15.933	61.513	7308	7.000	7308
7.100	524	-7134	-23951	33572	0.000	16.188	62.508	7454	7.100	7454
7.200	555	-7341	-24127	34224	0.000	16.443	63.503	7600	7.200	7600
7.300	586	-7553	-24300	34876	0.000	16.698	64.498	7746	7.300	7746
7.400	617	-7770	-24470	35528	0.000	16.953	65.493	7892	7.400	7892
7.500	648	-7992	-24637	36180	0.000	17.208	66.488	8038	7.500	8038
7.600	679	-8219	-24801	36832	0.000	17.463	67.483	8184	7.600	8184
7.700	710	-8451	-24962	37484	0.000	17.718	68.478	8330	7.700	8330
7.800	741	-8688	-25120	38136	0.000	17.973	69.473	8476	7.800	8476
7.900	772	-8930	-25275	38788	0.000	18.228	70.468	8622	7.900	8622
8.000	803	-9177	-25427	39440	0.000	18.483	71.463	8768	8.000	8768
8.100	834	-9429	-25576	40092	0.000	18.738	72.458	8914	8.100	8914
8.200	865	-9686	-25722	40744	0.000	18.993	73.453	9060	8.200	9060
8.300	896	-9948	-25865	41396	0.000	19.248	74.448	9206	8.300	9206
8.400	927	-10215	-26005	42048	0.000	19.503	75.443	9352	8.400	9352
8.500	958	-10487	-26142	42700	0.000	19.758	76.438	9498	8.500	9498
8.600	989	-10764	-26276	43352	0.000	20.013	77.433	9644	8.600	9644
8.700	1020	-11046	-26407	44004	0.000	20.268	78.428	9790	8.700	9790
8.800	1051	-11333	-26535	44656	0.000	20.523	79.423	9936	8.800	9936
8.900	1082	-11625	-26660	45308	0.000	20.778	80.418	10082	8.900	10082
9.000	1113	-11922	-26782	45960	0.000	21.033	81.413	10228	9.000	10228
9.100	1144	-12224	-26901	46612	0.000	21.288	82.408	10374	9.100	10374
9.200	1175	-12531	-27017	47264	0.000	21.543	83.403	10520	9.200	10520
9.300	1206	-12843	-27130	47916	0.000	21.798	84.398	10666	9.300	10666
9.400	1237	-13160	-27240	48568	0.000	22.053	85.393	10812	9.400	10812
9.500	1268	-13482	-27347	49220	0.000	22.308	86.388	10958	9.500	10958
9.600	1299	-13809	-27451	49872	0.000	22.563	87.383	11104	9.600	11104
9.700	1330	-14141	-27552	50524	0.000	22.818	88.378	11250	9.700	11250
9.800	1361	-14478	-27650	51176	0.000	23.073	89.373	11396	9.800	11396
9.900	1392	-14820	-27745	51828	0.000	23.328	90.368	11542	9.900	11542
10.000	1423	-15167	-27837	52480	0.000	23.583	91.363	11688	10.000	11688

PROPELLER NUMBER #4687 PITCH RATIO = 1.100 SIGMA = 1.5										
J	KTOUT	18QOUT	EFFIC	KT/J2	KQ/J3	QC	SIGM7	TAUC	J	TAUC
0.600	-6000	-1797	-4439	-4851	-1759	0.376	1.038	-1189	0.600	-1189
0.700	-5600	-1631	-4780	-4792	-1596	0.376	1.284	-1367	0.700	-1367
0.800	-5200	-1467	-5121	-4734	-1432	0.396	1.530	-1545	0.800	-1545
0.900	-4800	-1302	-5462	-4676	-1268	0.416	1.776	-1723	0.900	-1723
1.000	-4400	-1137	-5803	-4618	-1104	0.436	2.022	-1901	1.000	-1901
1.100	-4000	-972	-6144	-4560	-940	0.456	2.268	-2079	1.100	-2079
1.200	-3600	-807	-6485	-4502	-776	0.476	2.514	-2257	1.200	-2257
1.300	-3200	-642	-6826	-4444	-612	0.496	2.760	-2435	1.300	-2435
1.400	-2800	-477	-7167	-4386	-448	0.516	3.006	-2613	1.400	-2613
1.500	-2400	-312	-7508	-4328	-284	0.536	3.252	-2791	1.500	-2791
1.600	-2000	-147	-7849	-4270	-120	0.556	3.498	-2969	1.600	-2969
1.700	-1600	18	-8190	-4212	44	0.576	3.744	-3147	1.700	-3147
1.800	-1200	183	-8531	-4154	180	0.596	3.990	-3325	1.800	-3325
1.900										

Table 8

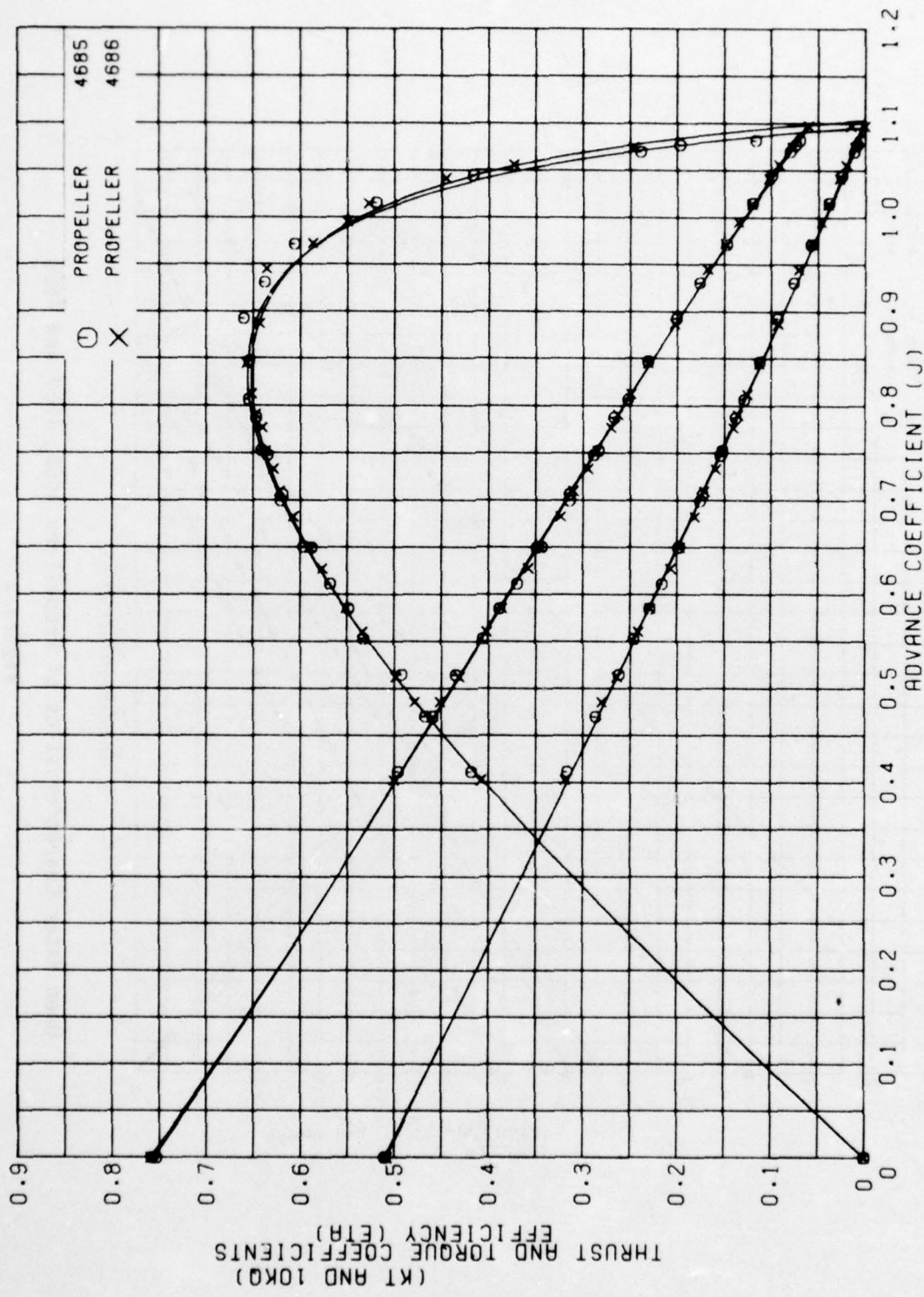
Cavitation Performance Characteristics of Propeller 4688

PROPELLER NUMBER 4688 PITCH RATIO = 1.300 SIGMA = 5.8										
J	KTOUT	18KOUT	EFFIC	KT/JZ	KQ/JJ	QC	SIGMAT	TAUC	J	TAUC
.6000	.3748	.6150	.4767	.6899	.2971	.0711	.4657	.2584	.7000	.2195
.6500	.3588	.5953	.4707	.6708	.2871	.0711	.4657	.2584	.7500	.2099
.7000	.3298	.5767	.4536	.6523	.2783	.0688	.4536	.2512	.8000	.1996
.7500	.2979	.6094	.4365	.6355	.2707	.0668	.4365	.2442	.8500	.1887
.8000	.2728	.6239	.4206	.6205	.2643	.0651	.4206	.2382	.9000	.1774
.8500	.2463	.6372	.4058	.6063	.2592	.0638	.4058	.2331	.9500	.1657
.9000	.2188	.6498	.3922	.5935	.2551	.0628	.3922	.2288	1.0000	.1537
1.0000	.1912	.6622	.3798	.5815	.2520	.0621	.3798	.2252	1.0500	.1414
1.1000	.1635	.6745	.3682	.5705	.2496	.0616	.3682	.2222	1.1000	.1288
1.2000	.1358	.6867	.3575	.5605	.2478	.0613	.3575	.2197	1.1500	.1160
1.3000	.1081	.6988	.3476	.5515	.2465	.0611	.3476	.2175	1.2000	.1031
1.4000	.0804	.7108	.3384	.5433	.2456	.0610	.3384	.2157	1.2500	.0902
1.5000	.0527	.7227	.3300	.5359	.2451	.0610	.3300	.2143	1.3000	.0774
1.6000	.0250	.7345	.3224	.5292	.2449	.0610	.3224	.2133	1.3500	.0647
1.7000	.0000	.7462	.3156	.5232	.2450	.0610	.3156	.2126	1.4000	.0521
1.8000	.0000	.7578	.3095	.5178	.2453	.0610	.3095	.2122	1.4500	.0396
1.9000	.0000	.7693	.3041	.5130	.2458	.0610	.3041	.2120	1.5000	.0271
2.0000	.0000	.7807	.2993	.5087	.2464	.0610	.2993	.2119	1.5500	.0146
2.1000	.0000	.7920	.2951	.5049	.2471	.0610	.2951	.2119	1.6000	.0021
2.2000	.0000	.8032	.2914	.5016	.2479	.0610	.2914	.2119	1.6500	.0000
2.3000	.0000	.8144	.2881	.4987	.2487	.0610	.2881	.2119	1.7000	.0000
2.4000	.0000	.8256	.2852	.4962	.2496	.0610	.2852	.2119	1.7500	.0000
2.5000	.0000	.8368	.2827	.4940	.2505	.0610	.2827	.2119	1.8000	.0000
2.6000	.0000	.8480	.2805	.4921	.2514	.0610	.2805	.2119	1.8500	.0000
2.7000	.0000	.8592	.2786	.4905	.2523	.0610	.2786	.2119	1.9000	.0000
2.8000	.0000	.8704	.2770	.4891	.2532	.0610	.2770	.2119	1.9500	.0000
2.9000	.0000	.8816	.2757	.4879	.2541	.0610	.2757	.2119	2.0000	.0000
3.0000	.0000	.8928	.2746	.4869	.2550	.0610	.2746	.2119	2.0500	.0000
3.1000	.0000	.9040	.2737	.4860	.2559	.0610	.2737	.2119	2.1000	.0000
3.2000	.0000	.9152	.2730	.4853	.2568	.0610	.2730	.2119	2.1500	.0000
3.3000	.0000	.9264	.2724	.4847	.2577	.0610	.2724	.2119	2.2000	.0000
3.4000	.0000	.9376	.2720	.4842	.2586	.0610	.2720	.2119	2.2500	.0000
3.5000	.0000	.9488	.2717	.4838	.2595	.0610	.2717	.2119	2.3000	.0000
3.6000	.0000	.9600	.2715	.4835	.2604	.0610	.2715	.2119	2.3500	.0000
3.7000	.0000	.9712	.2714	.4833	.2613	.0610	.2714	.2119	2.4000	.0000
3.8000	.0000	.9824	.2714	.4832	.2622	.0610	.2714	.2119	2.4500	.0000
3.9000	.0000	.9936	.2714	.4832	.2631	.0610	.2714	.2119	2.5000	.0000
4.0000	.0000	1.0048	.2714	.4832	.2640	.0610	.2714	.2119	2.5500	.0000
4.1000	.0000	1.0160	.2714	.4832	.2649	.0610	.2714	.2119	2.6000	.0000
4.2000	.0000	1.0272	.2714	.4832	.2658	.0610	.2714	.2119	2.6500	.0000
4.3000	.0000	1.0384	.2714	.4832	.2667	.0610	.2714	.2119	2.7000	.0000
4.4000	.0000	1.0496	.2714	.4832	.2676	.0610	.2714	.2119	2.7500	.0000
4.5000	.0000	1.0608	.2714	.4832	.2685	.0610	.2714	.2119	2.8000	.0000
4.6000	.0000	1.0720	.2714	.4832	.2694	.0610	.2714	.2119	2.8500	.0000
4.7000	.0000	1.0832	.2714	.4832	.2703	.0610	.2714	.2119	2.9000	.0000
4.8000	.0000	1.0944	.2714	.4832	.2712	.0610	.2714	.2119	2.9500	.0000
4.9000	.0000	1.1056	.2714	.4832	.2721	.0610	.2714	.2119	3.0000	.0000
5.0000	.0000	1.1168	.2714	.4832	.2730	.0610	.2714	.2119	3.0500	.0000
5.1000	.0000	1.1280	.2714	.4832	.2739	.0610	.2714	.2119	3.1000	.0000
5.2000	.0000	1.1392	.2714	.4832	.2748	.0610	.2714	.2119	3.1500	.0000
5.3000	.0000	1.1504	.2714	.4832	.2757	.0610	.2714	.2119	3.2000	.0000
5.4000	.0000	1.1616	.2714	.4832	.2766	.0610	.2714	.2119	3.2500	.0000
5.5000	.0000	1.1728	.2714	.4832	.2775	.0610	.2714	.2119	3.3000	.0000
5.6000	.0000	1.1840	.2714	.4832	.2784	.0610	.2714	.2119	3.3500	.0000
5.7000	.0000	1.1952	.2714	.4832	.2793	.0610	.2714	.2119	3.4000	.0000
5.8000	.0000	1.2064	.2714	.4832	.2802	.0610	.2714	.2119	3.4500	.0000
5.9000	.0000	1.2176	.2714	.4832	.2811	.0610	.2714	.2119	3.5000	.0000
6.0000	.0000	1.2288	.2714	.4832	.2820	.0610	.2714	.2119	3.5500	.0000
6.1000	.0000	1.2400	.2714	.4832	.2829	.0610	.2714	.2119	3.6000	.0000
6.2000	.0000	1.2512	.2714	.4832	.2838	.0610	.2714	.2119	3.6500	.0000
6.3000	.0000	1.2624	.2714	.4832	.2847	.0610	.2714	.2119	3.7000	.0000
6.4000	.0000	1.2736	.2714	.4832	.2856	.0610	.2714	.2119	3.7500	.0000
6.5000	.0000	1.2848	.2714	.4832	.2865	.0610	.2714	.2119	3.8000	.0000
6.6000	.0000	1.2960	.2714	.4832	.2874	.0610	.2714	.2119	3.8500	.0000
6.7000	.0000	1.3072	.2714	.4832	.2883	.0610	.2714	.2119	3.9000	.0000
6.8000	.0000	1.3184	.2714	.4832	.2892	.0610	.2714	.2119	3.9500	.0000
6.9000	.0000	1.3296	.2714	.4832	.2901	.0610	.2714	.2119	4.0000	.0000
7.0000	.0000	1.3408	.2714	.4832	.2910	.0610	.2714	.2119	4.0500	.0000
7.1000	.0000	1.3520	.2714	.4832	.2919	.0610	.2714	.2119	4.1000	.0000
7.2000	.0000	1.3632	.2714	.4832	.2928	.0610	.2714	.2119	4.1500	.0000
7.3000	.0000	1.3744	.2714	.4832	.2937	.0610	.2714	.2119	4.2000	.0000
7.4000	.0000	1.3856	.2714	.4832	.2946	.0610	.2714	.2119	4.2500	.0000
7.5000	.0000	1.3968	.2714	.4832	.2955	.0610	.2714	.2119	4.3000	.0000
7.6000	.0000	1.4080	.2714	.4832	.2964	.0610	.2714	.2119	4.3500	.0000
7.7000	.0000	1.4192	.2714	.4832	.2973	.0610	.2714	.2119	4.4000	.0000
7.8000	.0000	1.4304	.2714	.4832	.2982	.0610	.2714	.2119	4.4500	.0000
7.9000	.0000	1.4416	.2714	.4832	.2991	.0610	.2714	.2119	4.5000	.0000
8.0000	.0000	1.4528	.2714	.4832	.3000	.0610	.2714	.2119	4.5500	.0000
8.1000	.0000	1.4640	.2714	.4832	.3009	.0610	.2714	.2119	4.6000	.0000
8.2000	.0000	1.4752	.2714	.4832	.3018	.0610	.2714	.2119	4.6500	.0000
8.3000	.0000	1.4864	.2714	.4832	.3027	.0610	.2714	.2119	4.7000	.0000
8.4000	.0000	1.4976	.2714	.4832	.3036	.0610	.2714	.2119	4.7500	.0000
8.5000	.0000	1.5088	.2714	.4832	.3045	.0610	.2714	.2119	4.8000	.0000
8.6000	.0000	1.5200	.2714	.4832	.3054	.0610	.2714	.2119	4.8500	.0000
8.7000	.0000	1.5312	.2714	.4832	.3063	.0610	.2714	.2119	4.9000	.0000
8.8000	.0000	1.5424	.2714	.4832	.3072	.0610	.2714	.2119	4.9500	.0000
8.9000	.0000	1.5536	.2714	.4832	.3081	.0610	.2714	.2119	5.0000	.0000
9.0000	.0000	1.5648	.2714	.4832	.3090	.0610	.2714	.2119	5.0500	.0000
9.1000	.0000	1.5760	.2714	.4832	.3099	.0610	.2714	.2119	5.1000	.0000
9.2000	.0000	1.5872	.2714	.4832	.3108	.0610	.2714	.2119	5.1500	.0000
9.3000	.0000	1.5984	.2714	.4832	.3117	.0610	.2714	.2119	5.2000	.0000
9.4000	.0000	1.6096	.2714	.4832	.3126	.0610	.2714	.2119	5.2500	.0000
9.5000	.0000	1.6208	.2714	.4832	.3135	.0610	.2714	.2119	5.3000	.0000
9.6000	.0000	1.6320	.2714	.4832	.3144	.0610	.2714	.2119	5.3500	.0000
9.7000	.0000	1.6432	.2714	.4832	.3153	.0610	.2714	.2119	5.4000	.0000
9.8000	.0000	1.6544	.2714	.4832	.3162	.0610	.2714	.2119	5.4500	.0000
9.9000	.0000	1.6656	.2714	.4832	.3171	.0610	.2714	.2119	5.5000	.0000
10.0000	.0000	1.6768	.2714	.4832	.3180	.0610	.2714	.2119	5.5500	.0000
10.1000	.0000	1.6880	.2714	.4832	.3189	.0610	.2714	.2119	5.6000	.0000
10.2000	.0000	1.6992	.2714	.4832	.3198	.0610	.2714	.2119	5.6500	.0000
10.3000	.0000	1.7104	.2714	.4832	.3207	.0610	.2714	.2119	5.7000	.0000
10.4000	.0000	1.7216	.2714	.4832	.3216	.0610	.2714	.2119	5.7500	.0000
10.5000	.0000	1.7328	.2714	.4832	.3225	.0610	.2714	.2119	5.8000	.0000
10.6000	.0000	1.7440	.2714	.4832	.3234	.0610	.2714	.2119	5.8500	.0000
10.7000	.0000	1.7552	.2714	.4832	.3243	.0610	.2714	.2119	5.9000	.0000
10.8000	.0000	1.7664	.2714	.4832	.3252	.0610	.2714	.2119	5.9500	.0000
10.9000	.0000	1.7776	.2714	.4832	.3261	.0610	.2714	.2119	6.0000	.0000
11.0000	.0000	1.7888	.2714	.4832	.3270	.0610	.2714	.2119	6.0500	.0000
11.1000	.0000	1.8000	.2714	.4832	.3279	.0610	.2714	.2119	6.1000	.0000
11.2000	.0000	1.8112	.2714	.4832	.3288	.0610	.2714	.2119	6.1500	.0000
11.3000	.0000	1.8224	.2714	.4832	.3297	.0610	.2714	.2119	6.200	



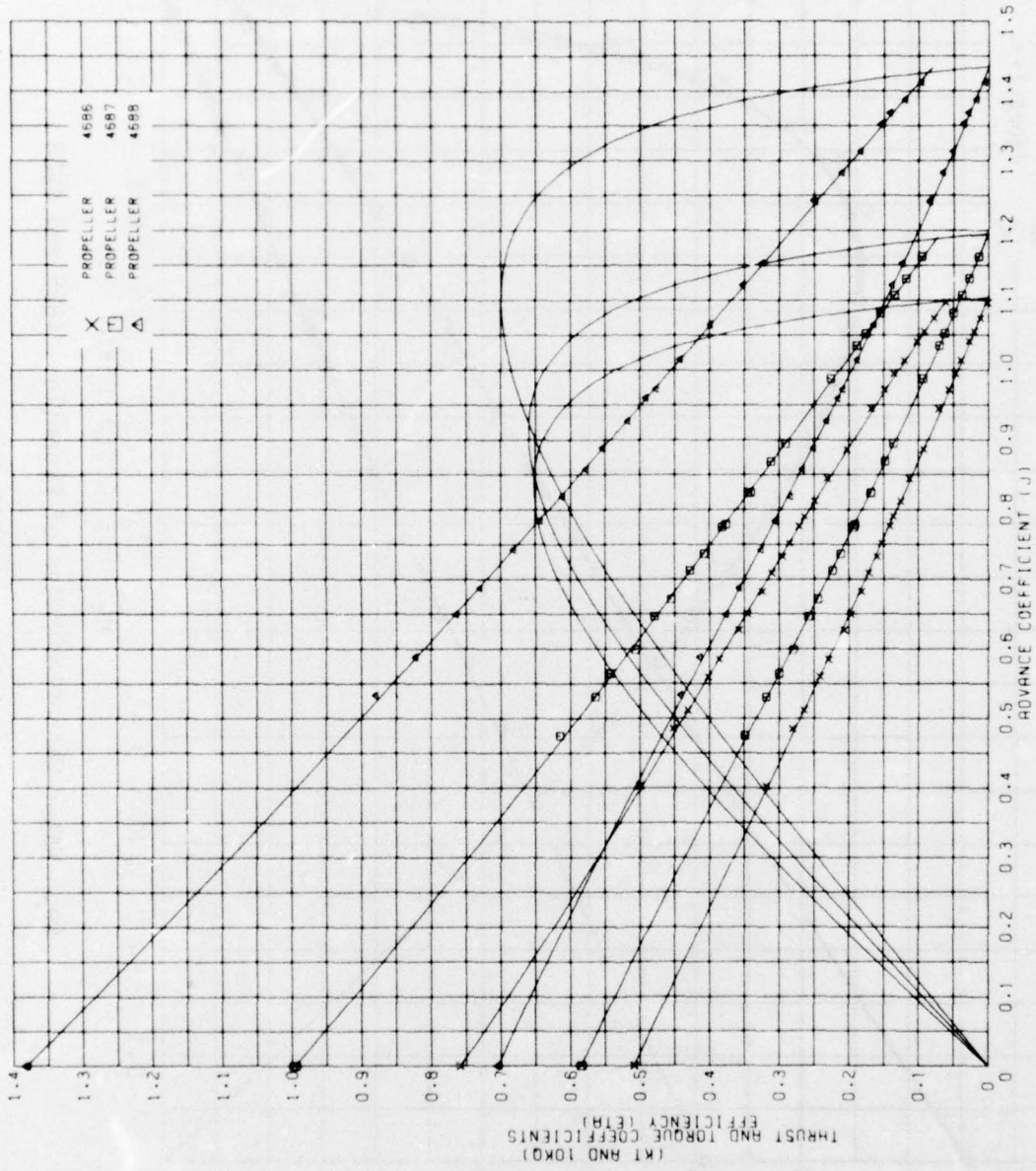
Photograph of a Commercial Propeller

Figure 1



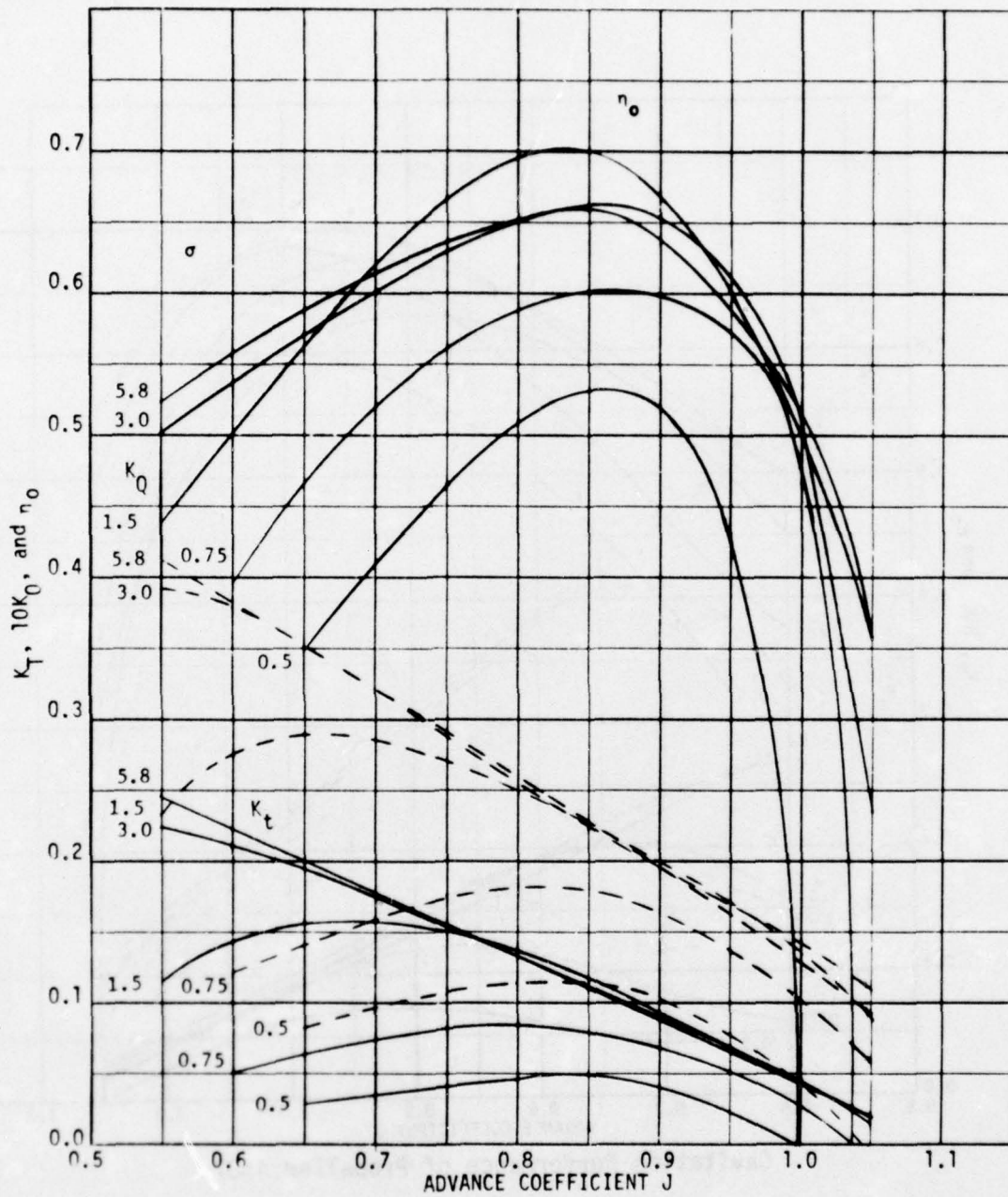
Open Water Characteristics of Propellers 4685 and 4686

Figure 2



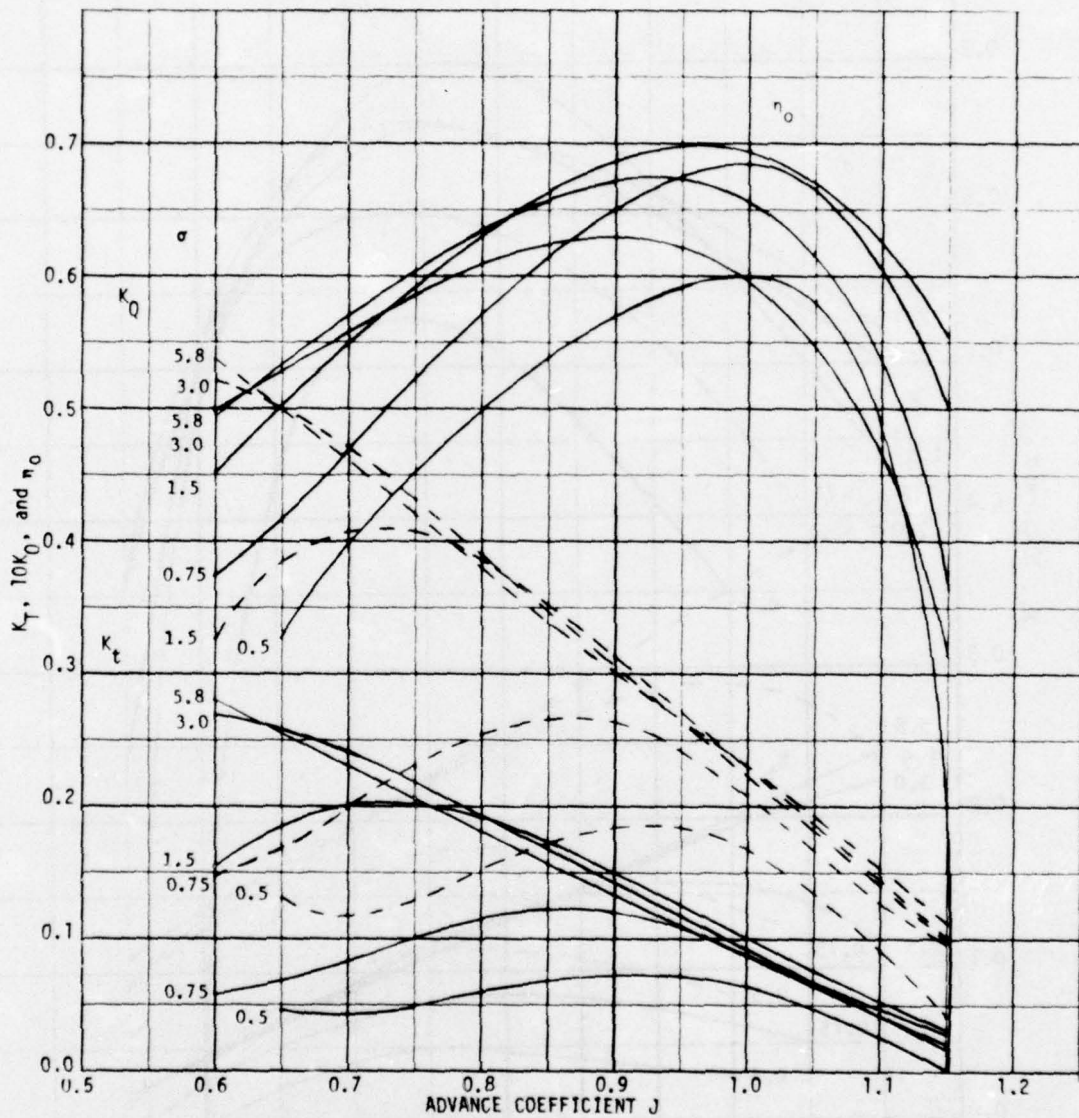
Open Water Characteristics of Propellers 4686, 4687 and 4688

Figure 3



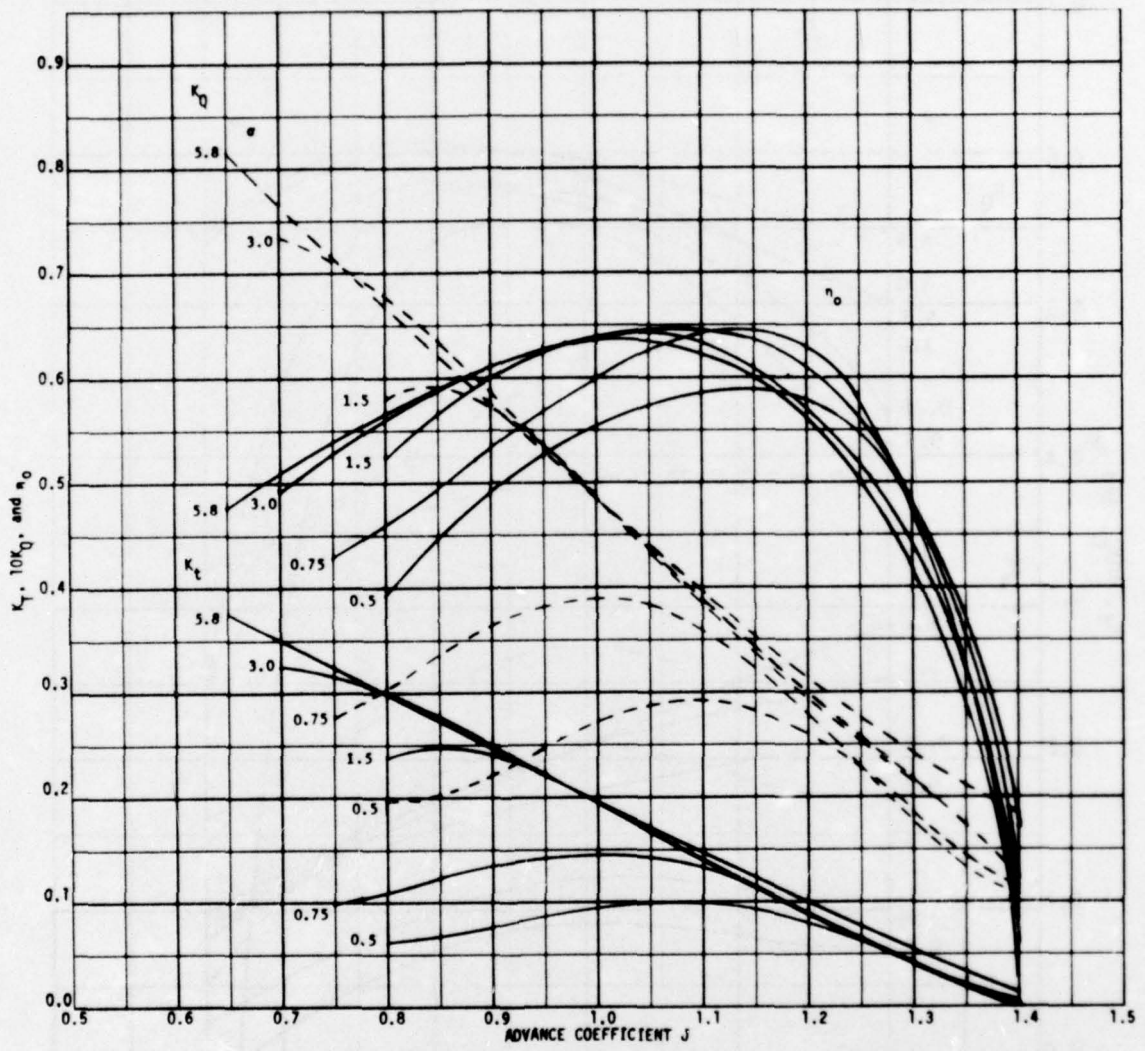
Cavitation Performance of Propeller 4686

Figure 4



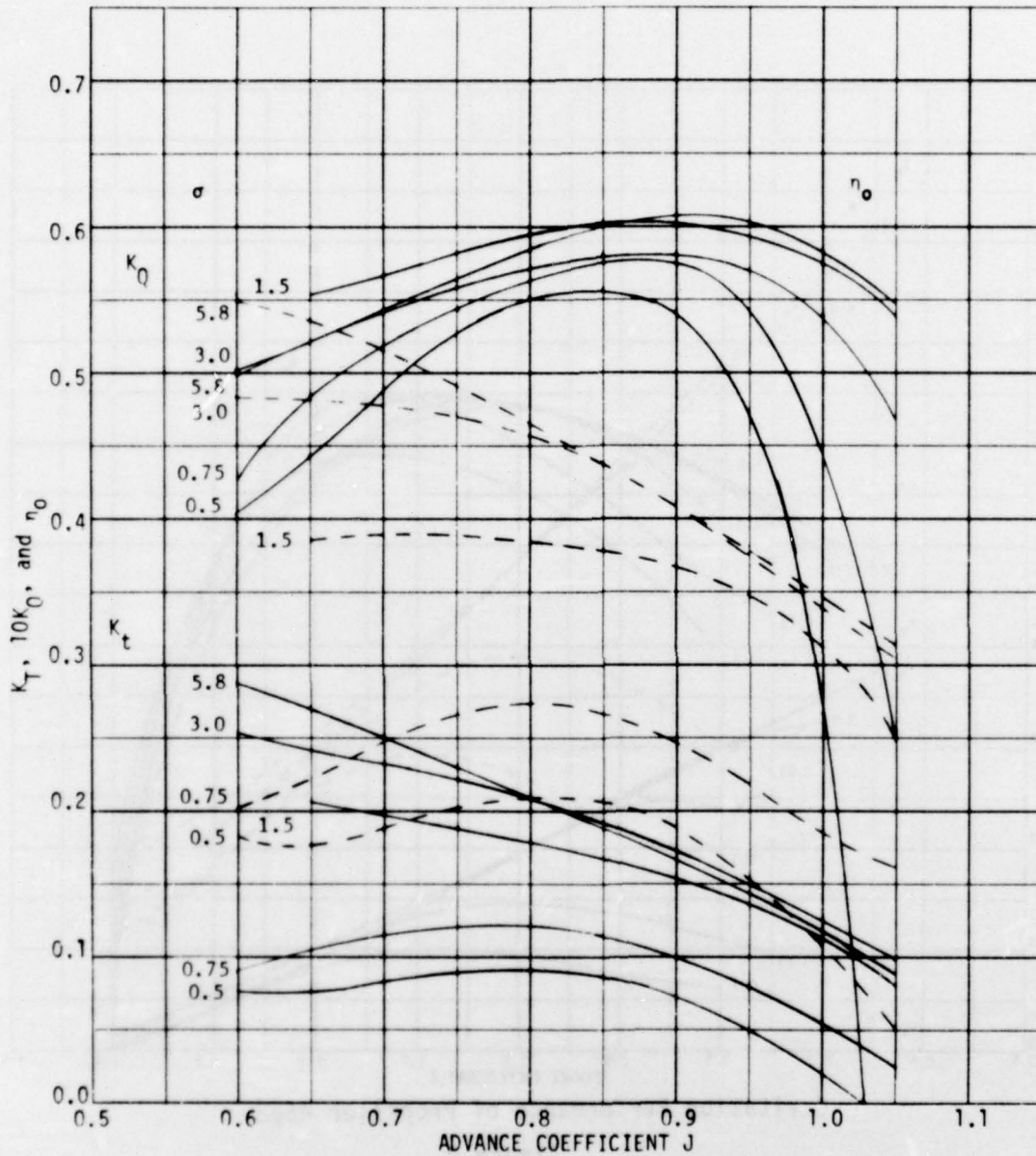
Cavitation Performance of Propeller 4687

Figure 5



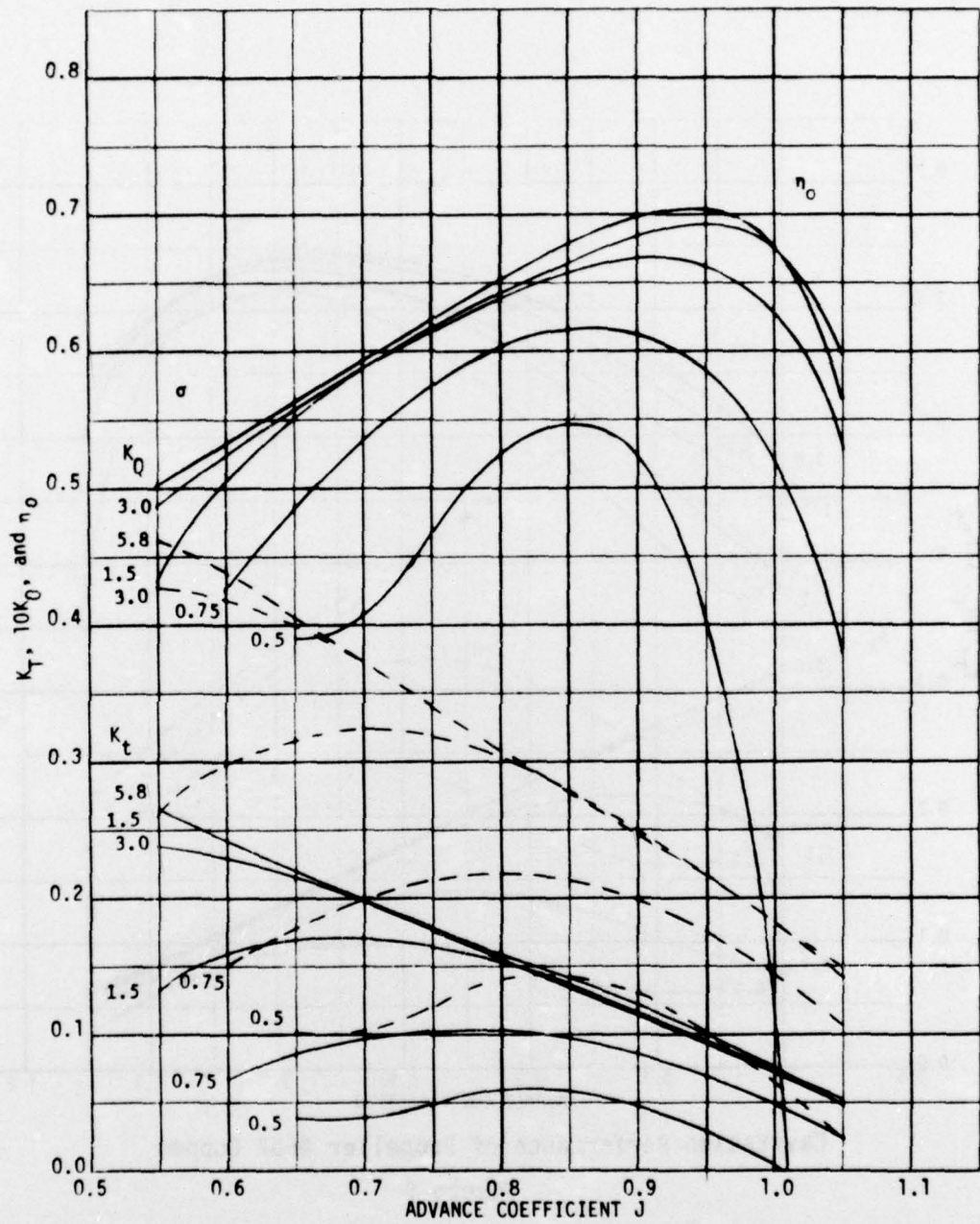
Cavitation Performance of Propeller 4688

Figure 6



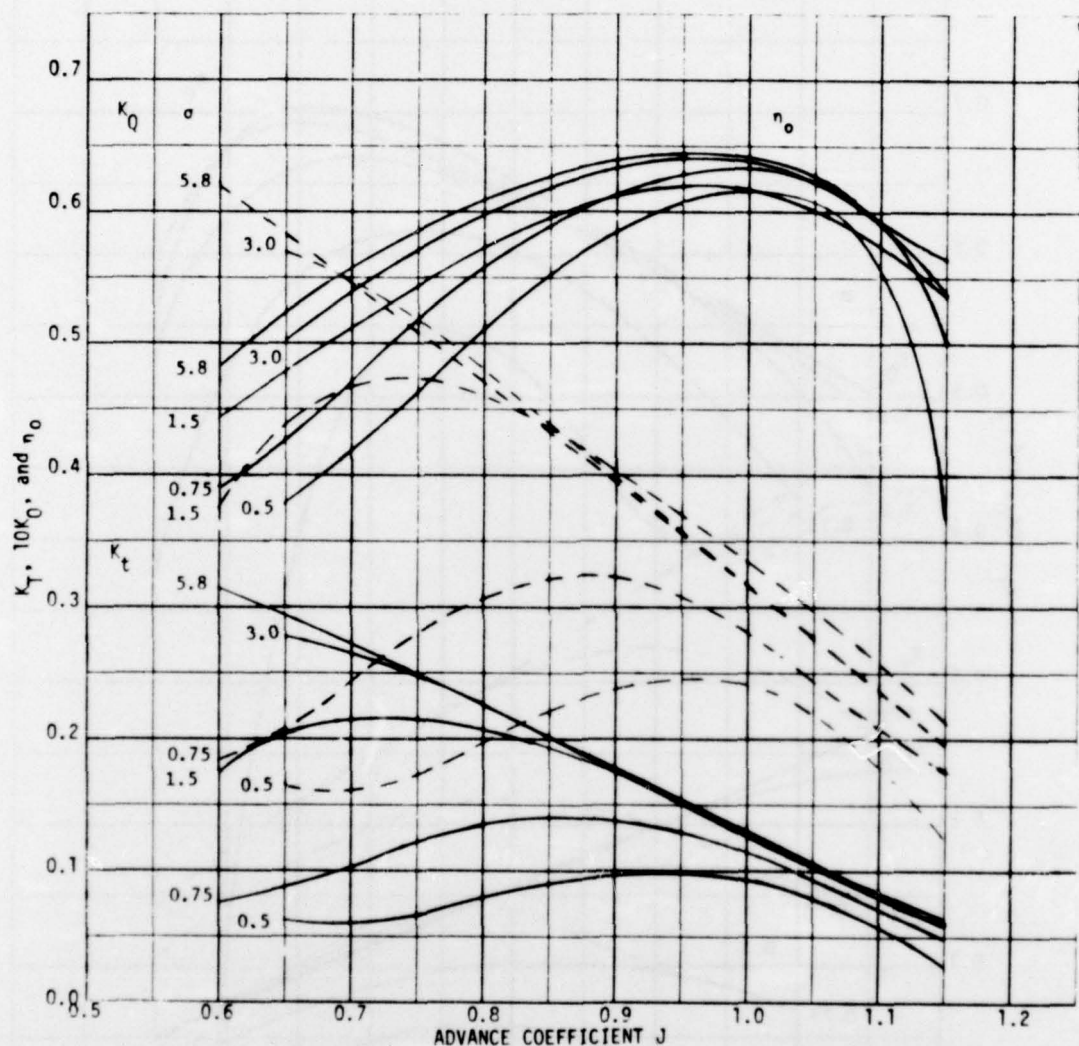
Cavitation Performance of Propeller 4685 Cupped

Figure 7

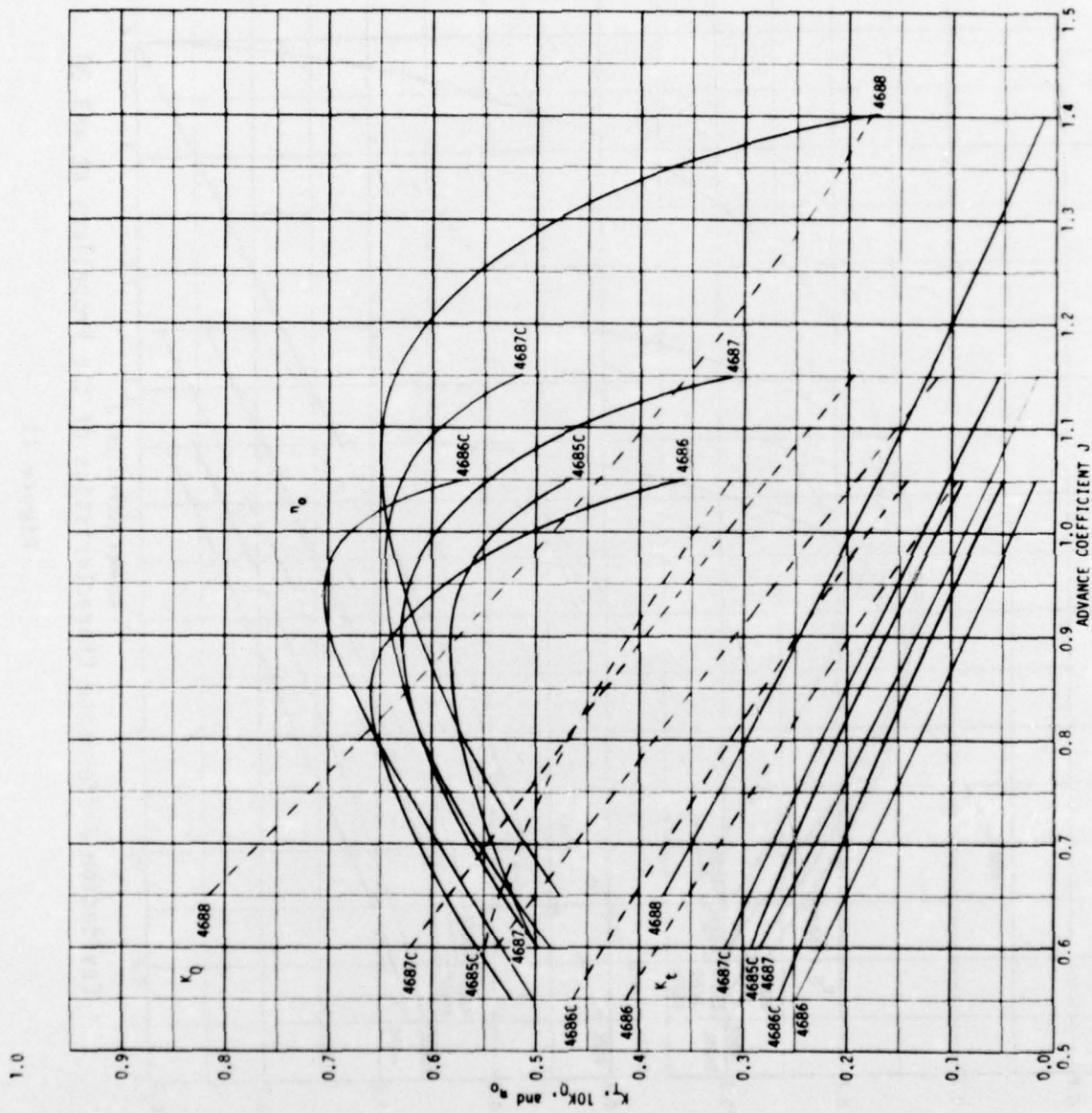


Cavitation Performance of Propeller 4686 Cupped

Figure 8

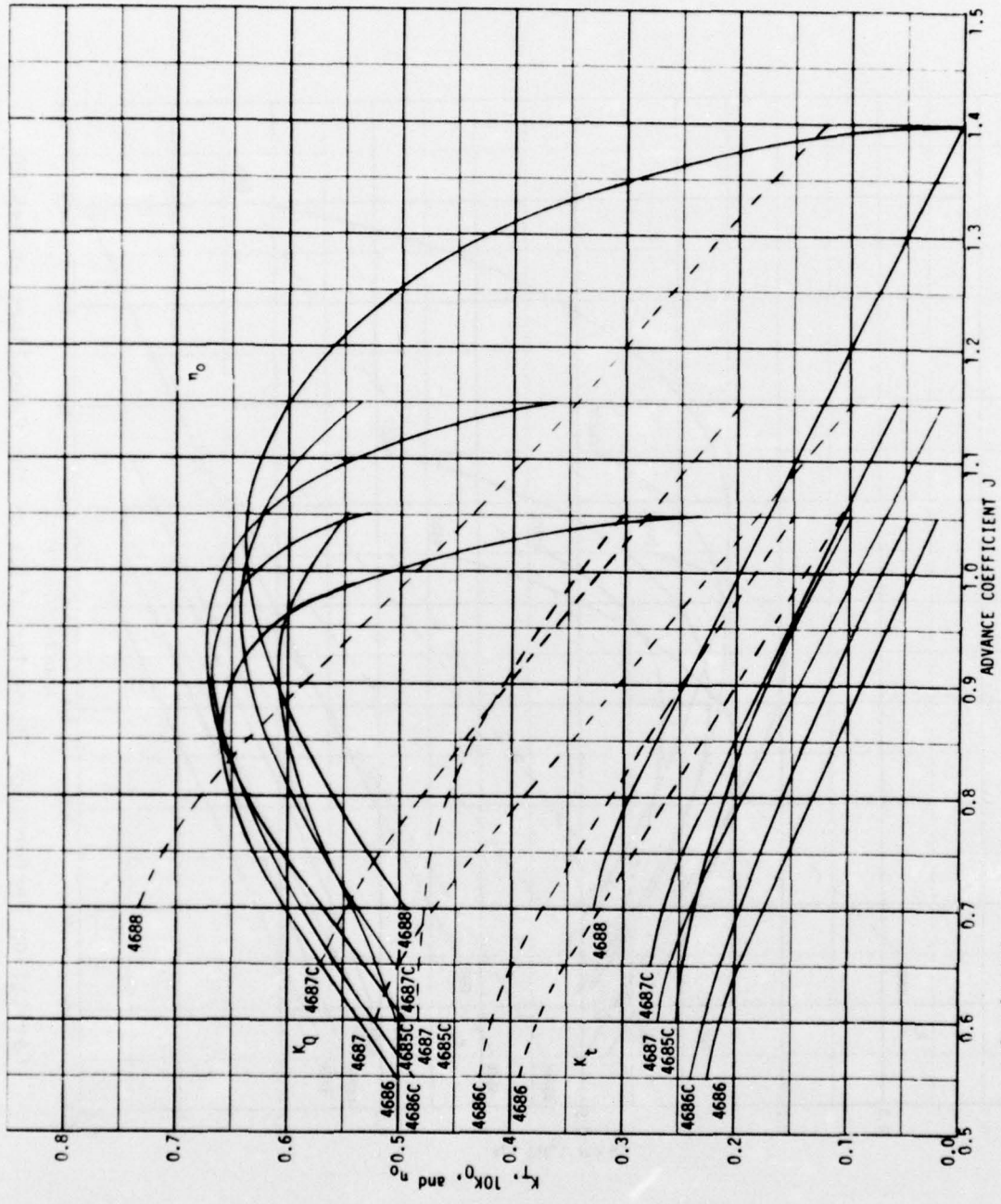


Cavitation Performance of Propeller 4687 Cupped
 Figure 9



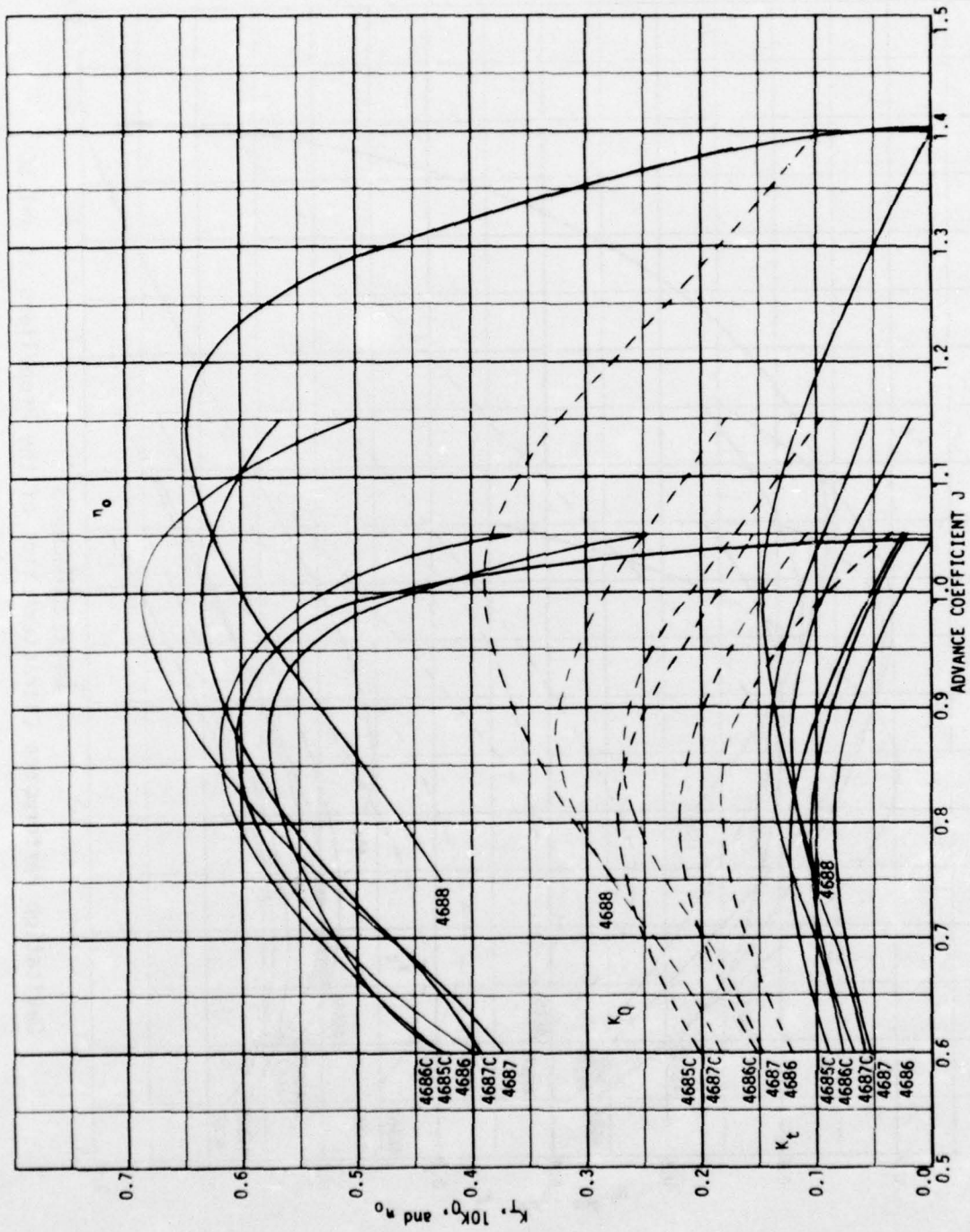
Cavitation Performance Characteristics of the Propellers at $\sigma=5.80$

Figure 10



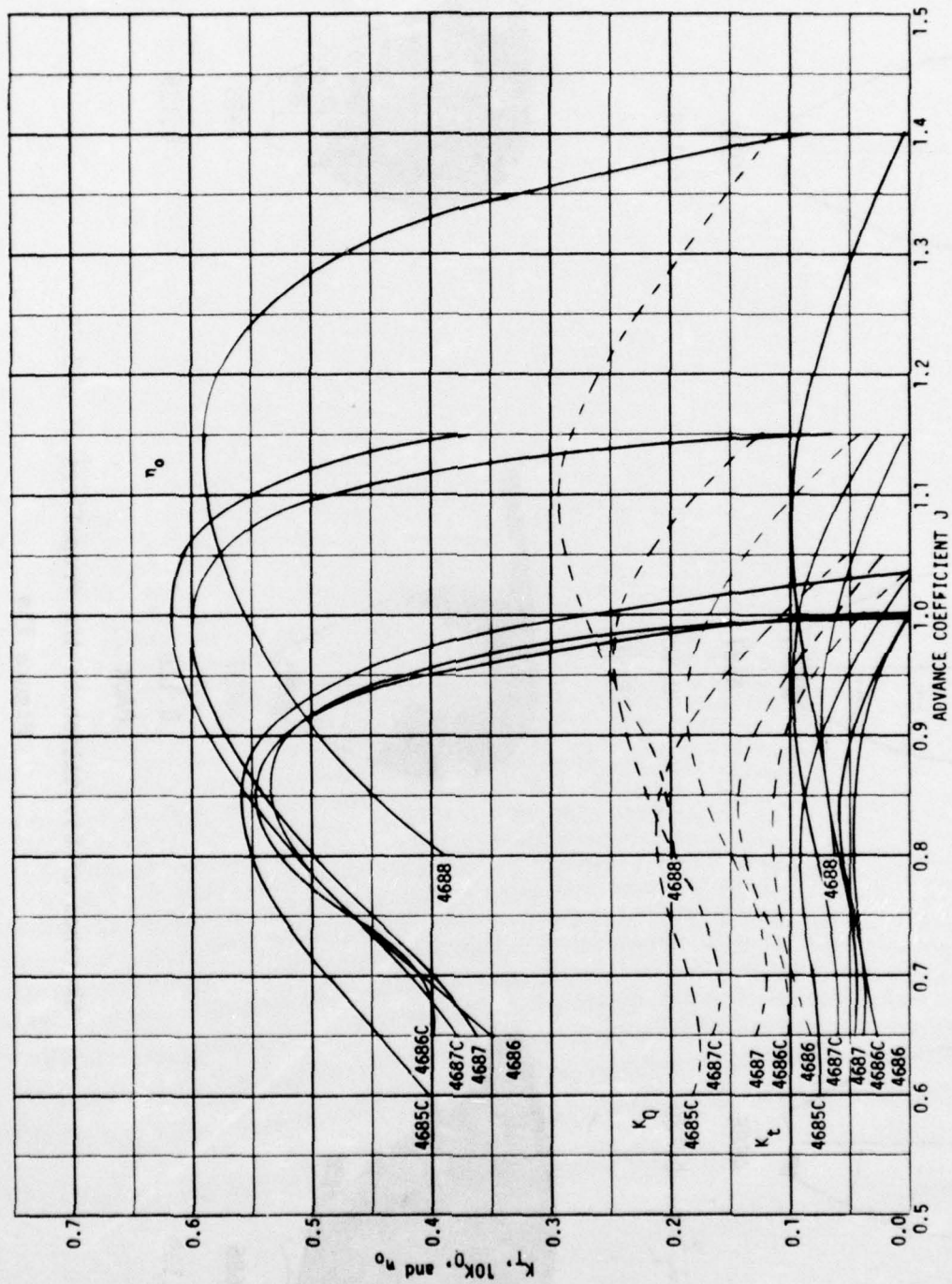
Cavitation Performance Characteristics of the Propellers at $\sigma=3.00$

Figure 11



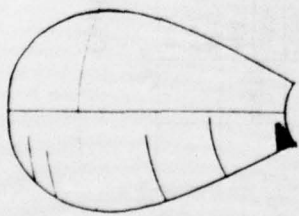
Cavitation Performance Characteristics of the Propellers at $\sigma=0.75$

Figure 13



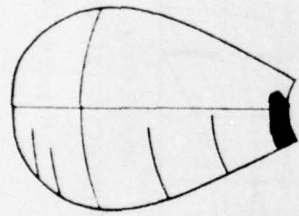
Cavitation Performance Characteristics of the Propellers at $\sigma=0.50$

Figure 14



4686

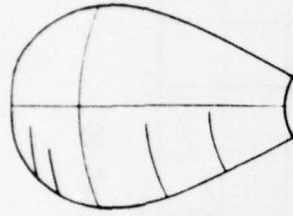
$$K_T/J_T^2 = 0.139$$



4687

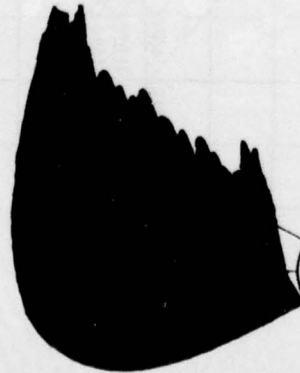
$$0.120$$

FACE



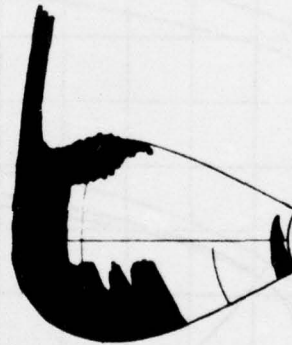
4688

$$0.129$$



4686

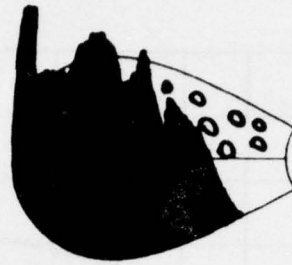
$$K_T/J_T^2 = 0.139$$



4687

$$0.120$$

BACK

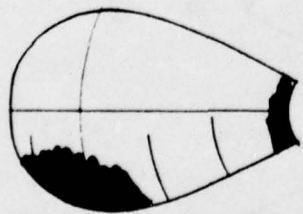


4688

$$0.129$$

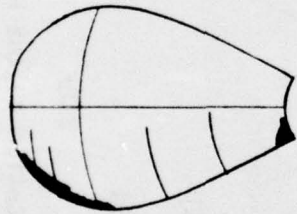
Sketches of Cavitation on the Propellers at $\sigma=0.75$

Figure 15a



4685C

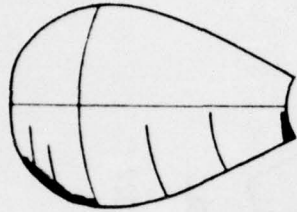
$$K_T/J_T^2 = 0.121$$



4686C

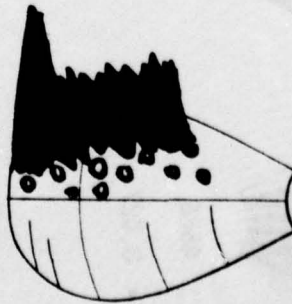
$$0.135$$

FACE



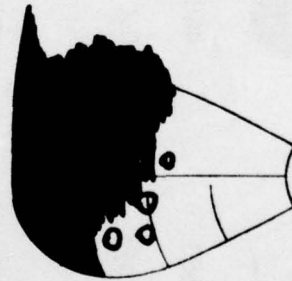
4687C

$$0.112$$



4685C

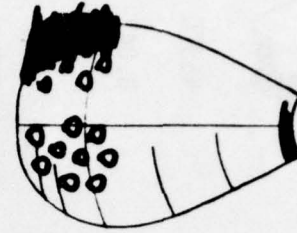
$$K_T/J_T^2 = 0.121$$



4686C

$$0.135$$

BACK

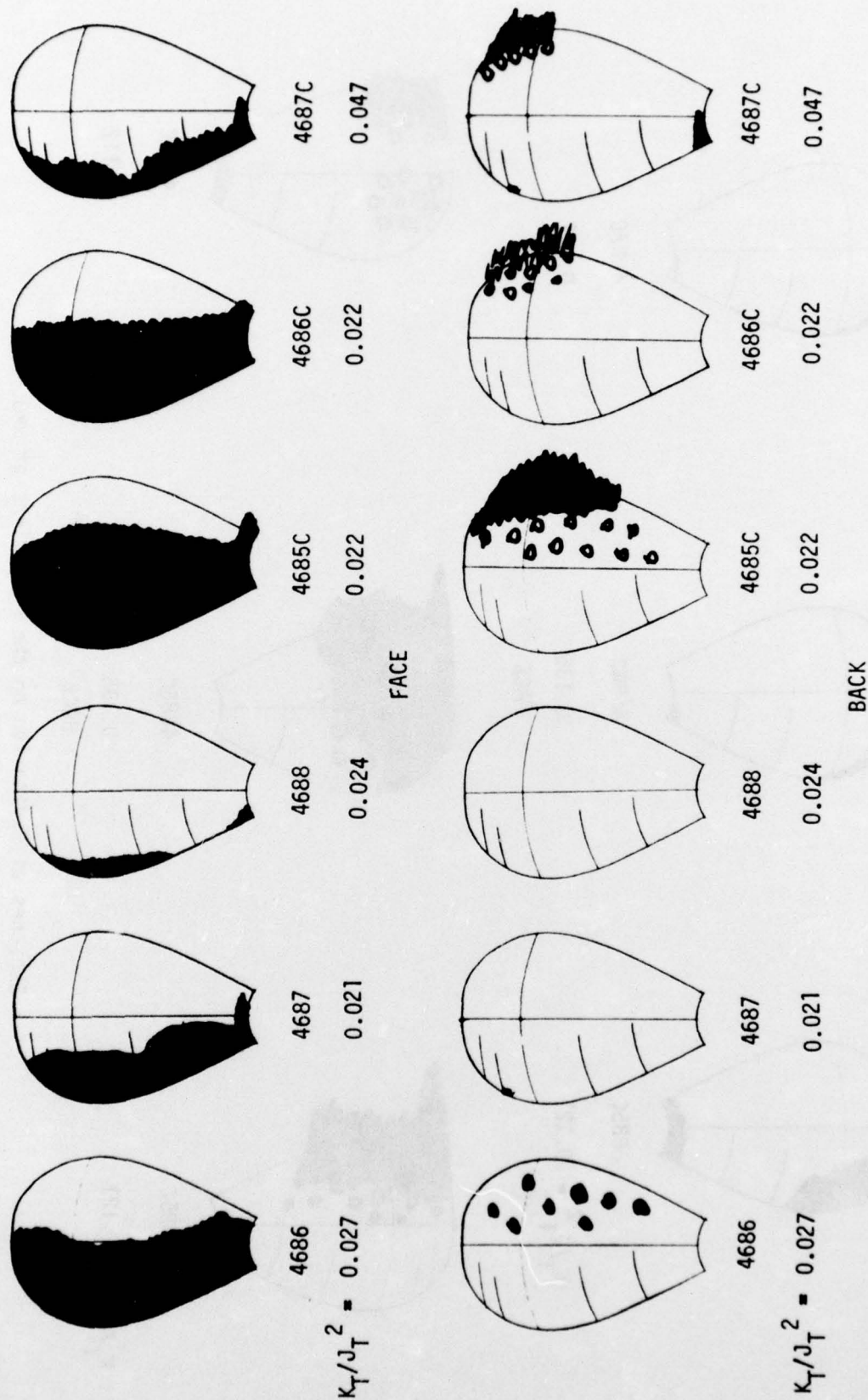


4687C

$$0.112$$

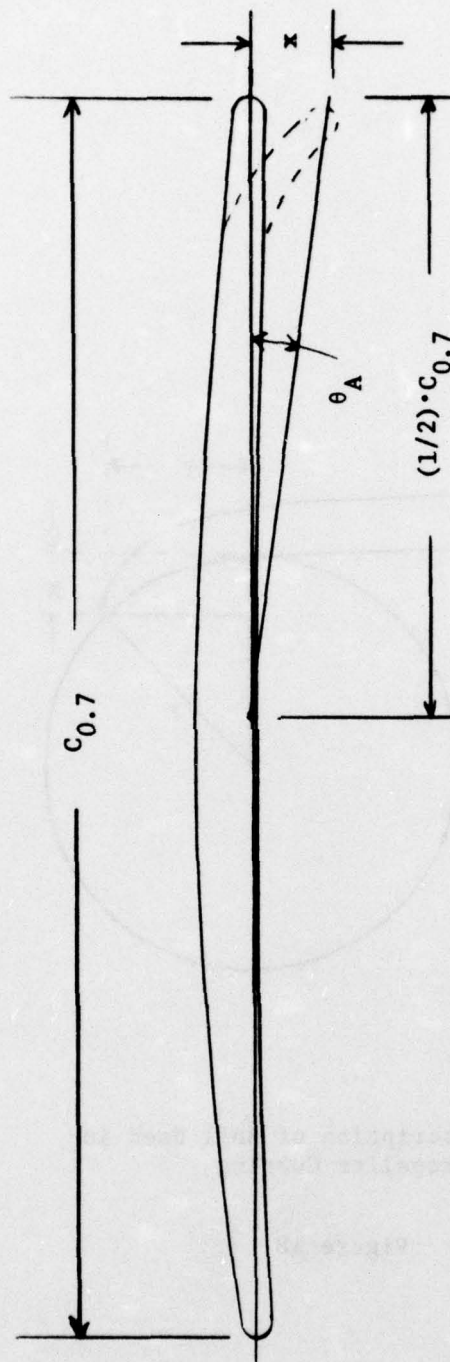
Sketches of Cavitation on the Propellers at $\sigma=0.75$

Figure 15b



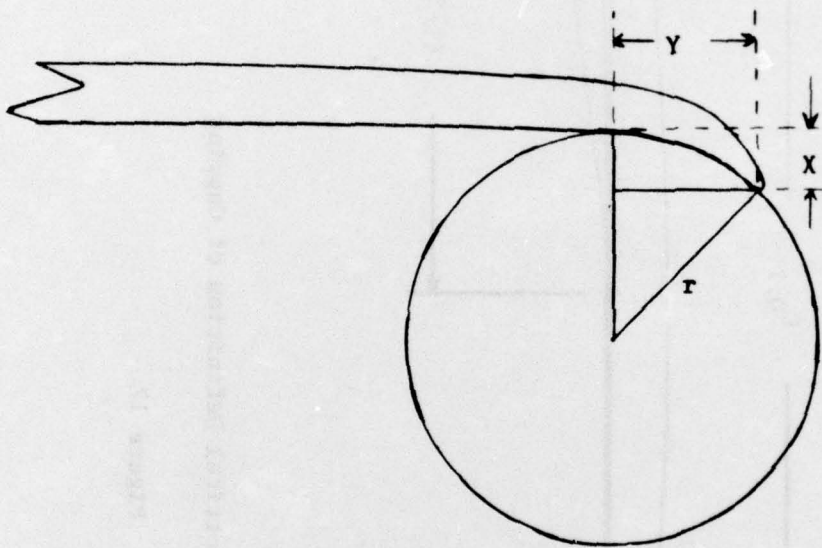
Sketches of Cavitation on the Propellers at $\sigma=0.75$

Figure 16



Geometrical Definition of Cupping

Figure 17



Geometrical Description of Ball Used in
Propeller Cupping

Figure 18

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