

**INVESTIGATION OF THE INFLUENCE OF PROPELLER
LOADING ON A SHIP RUDDER IN THE BOLLARD (J=0)
CONDITION**

A.F. Molland, S.R. Turnock and J.E.T. Smithwick

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SUMMARY

The results of tests on a rudder operating downstream of a propeller are presented. The tests were carried out in an open laboratory. The tests were therefore carried out at true zero speed. This corresponds to an advance ratio of $J=0$ or bollard pull condition. Performance comparisons were made for seven rudder angles between -45° and $+45^\circ$ at two rates of revolution 1160 and 1460rpm.

The tests consisted of a series of parametric studies into the effect of longitudinal and lateral distance between the propeller and rudder. A five-component strain-gauge dynamometer was used to measure lift, drag and three moments on the rudder. A rotating strain gauge dynamometer measured the developed thrust and torque of the propeller.

Results are presented in the form of non-dimensional coefficients lift (C_L^*), drag (C_D^*). The influence of rudder on propeller performance is given in terms of non-dimensional thrust (K_T) coefficient and torque (K_Q) coefficient.

The results provide data for detailed rudder design, for numerical modelling of the rudder and propeller interaction problem and for use in low speed manoeuvring simulations.

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NOMENCLATURE

A	Rudder Area (S.c)
AR_G	Geometric aspect ratio
c	Rudder chord
D	Propeller diameter
CP_c	Centre of pressure chordwise, %c, measured from leading edge
CP_s	Centre of pressure spanwise, %S, measured from root
C_D	Drag coefficient ($d/1/2\rho AV^2$)
C_D^*	Drag coefficient ($d/1/2\rho AK_T n^2 D^2$)
C_L	Lift coefficient ($L/1/2\rho AV^2$)
C_L^*	Lift coefficient ($L/1/2\rho AK_T n^2 D^2$)
C_n	Normal force coefficient, normal to rudder per unit span
C_T^*	Propeller thrust coefficient ($8T/\rho\pi D^2[V^2+(0.7\pi nD)^2]$)
C_Q^*	Propeller torque coefficient ($8T/\rho\pi D^2[V^2+(0.7\pi nD)^2]$)
d	Rudder drag force, body (ship) axis
L	Rudder lift force, normal to body (ship) axis
N	Normal force, normal to centreline of rudder
n	Propeller revs per sec
V	Wind speed (free-stream)
Q	Propeller torque
T	Propeller thrust
J	Propeller advance coefficient (V/nD)
K_T	Propeller thrust coefficient ($T/\rho n^2 D^4$)
K_Q	Rudder torque coefficient ($Q/\rho n^2 D^5$)
S	Rudder span
t	Rudder section thickness
X	Longitudinal distance, propeller plane to rudder leading edge in line with propeller axis
Y	Lateral distance between propeller axis and rudder stock
Z	Vertical distance between rudder root and propeller axis
ψ	Propeller advance angle ($\tan^{-1}[J/0.7\pi]$)
δ	Rudder angle relative to body(ship) axis
α	Net inflow angle
ρ	Mass density

1. INTRODUCTION

This report represents part of a continued programme under the MOSES (Manoeuvring of Ships Estimation Schemes) contract.

Extensive work has been carried out on all-movable rudders at zero advance ratio ($J=0$) but with the increasing use of skeg-rudders in ships and large yachts further investigation of performance of a skeg-rudder in the wake of a propeller at bollard pull condition ($J=0$) is considered necessary.

This report presents the results from a detailed investigation into the performance of a skeg-rudder and all-movable rudder in the wake of a propeller. The experiments were carried out in the University of Southampton Sir George Edwards Laboratory.

A comprehensive presentation is made of the results obtained during testing carried out in January 1996. Section 2 details the rudder and propeller models used. The test rig and the tests carried out are described in Sections 3 and 4.

Sections 5 and 6 detail respectively the data reduction and its presentation. Section 7 discusses the results. Conclusions and recommendations are presented in Section 8.

2. DESCRIPTION OF MODELS

2.1 Rudders

For these tests, two rudders were used, designated Rudder No. 2 and Rudder No. 0 (using the same designations as in Refs. 1-4). Rudder No. 2 is rectangular with a chord of 667mm, a NACA 0020 section, and a span of 1000mm. Rudder No. 0 is a skeg rudder with a mean chord of 667mm, a NACA 0020 section, a span of 1000mm and a taper ratio of 0.8. A detailed description of the method of manufacture of the rudder models is given in Ref. 5. Table I presents the particulars of the rudders used in the current investigation and Figure 1 their overall dimensions.

For the tests carried out, the rudders had a roughness strip attached with its leading edge 5.7% of the chord from the leading edge on both sides of the rudder. The roughness strips were manufactured from 12mm wide double-sided tape densely covered with 100 grade carborundum grit (0.15mm diameter).

2.2 Propeller

A representative propeller design, based on the Wageningen B4.40 was used. The propeller has four blades, a diameter of 800mm and a blade area ratio of 0.40. Modifications made to the basic Wageningen design are detailed in Ref. 6 and consisted of altering the blade root shape to allow an adjustable pitch design with four separate blades and a split hub, removing rake and decreasing blade sweep to reduce centripetal loading moments at the root and also increasing the hub/diameter ratio from 0.167 to 0.25. Overall propeller details are summarised in Table II and a comparison of the basis and modified Wageningen B4.40 can be seen in Figure 2.

The split hub was manufactured from aluminium alloy and a positive clamping action allows the four blades to be rotated and clamped to the desired pitch ratio setting. The four blades were manufactured using hybrid carbon/glass fibre laid up in the same split female mould to produce identical blades. The production of the composite blades is detailed in Ref. 7 and the machining of the female mould in Ref. 6. In appearance the hub/blade root region is very similar to that of a typical controllable pitch propeller.

3. APPARATUS

3.1 General

The tests were carried out in the open in the Sir George Edwards Laboratory at the University of Southampton. The overall rig for testing the interaction of ship rudders and propellers is shown in Figure 3. The rig consists of two independent units which allow free-stream (open-water) tests to be carried out independently on rudders and propellers as well as the investigation of their interaction. The units are tested with a raised floor to simulate the same conditions as those tested in the wind tunnel. The configuration is the same as that in the University of Southamptons 7' x 5' wind tunnel. Designs for the raised floor framework and general configuration can be seen in Figures 6 to 8.

The University of Southampton safety policy also requires that a risk assessment form is completed before any equipment is used this is shown in Figure 9.

3.2 Rudder Rig/Dynamometer

The rig consists of a steel structure attached to the floor which supports a five-component strain gauge dynamometer below the tunnel working section. A description of the design and calibration of the dynamometer is given in Ref. 8. The rudder is bolted directly to the dynamometer. The dynamometer is levelled and adjusted vertically so that there is a small gap of approximately 2.5mm (0.004c) between the rudder root and the floor.

The all-movable rudder No. 2 can be controlled using a stepper motor controlled turntable to set incidence angle to the propeller flow. This was conducted through the data acquisition PC via the control program.

3.3 Propeller Rig

Full details of the propeller rig are given in Ref. 5. The rig is designed in such a way that the propeller can be adjusted vertically, longitudinally and at an angle of attack to the flow if required. The tests reported on were carried out with the propeller's axis of rotation 600mm above the raised floor. The propeller rotates anti-clockwise when viewed from aft (looking upstream).

An in line strain gauge dynamometer mounted close to the propeller measures the delivered thrust and torque. The design and static calibration of this dynamometer is detailed in Ref. 9. The two measurement components of the dynamometer are connected via a slip-ring assembly to Fyde Bridge balance units with a built in stabilised power supply. The bridge balance output voltage is measured directly (without amplification) using a Schlumberger Minate Digital Voltmeter.

A variable frequency inverter is used to control the 30kw electric drive motor and the propeller rpm can be continuously varied in small discrete steps between 0 and 3000 rpm. An optical shaft encoder was used to measure propeller revolutions and gives a voltage proportional to shaft rpm.

3.4 Data Acquisition System

The large number of individual data readings required the use of an automated system for data acquisition. An enhanced acquisition system has been established involving a new faster PC and new interface cards. The system is essentially the same as detailed in Refs. 1 and 2. but the software has been enhanced and changed to suit the new acquisition cards together with several added facilities.

Bridge output signals from the five-component rudder dynamometer and the propeller thrust/torque dynamometer are measured using a digital voltmeter connected to the data acquisition PC via an IEEE interface. Supply voltages for the dynamometers are measured using an analog to digital

acquisition card inside the PC and control of the scanivalve unit is executed via a parallel interface also located on the card. Both the parallel and analog ports are connected via an interface box to allow versatile connection and more than one control function. All acquisition is controlled by software running on a the RM personal computer and the results stored on hard disk for subsequent analysis. A control system schematic can be seen in Figure 4.

4. TESTS

4.1 General

Rudder No. 2 was tested in the base position with the propeller axis 600mm above the wind tunnel floor, zero lateral separation, and a longitudinal separation $X/D=0.39$. A four-bladed propeller configuration with a pitch ratio setting, $P/D=0.95$, was used. This arrangement corresponded to the mid-longitudinal position used in previous tests reported in Ref. 14. Correspondence of results between test sessions was good and demonstrated the repeatability of the test methodology.

4.2 Rudder-Propeller Interaction

Both the performance of skeg-rudder No. 0 and the all-movable rudder No. 2 were investigated in the bollard pull condition ($J=0$).

In the base position both rudders were tested at a rate of revolution of the propeller of 1160rpm and 1460rpm. Measurement of the propeller and rudder forces were made at incidence increments of 5° between -45° and $+45^\circ$ for the all-movable rudder No.2 and -35° to $+35^\circ$ for the skeg-rudder No. 0. Measurements were taken for the skeg-rudder-propeller combination with a lateral separation $Y/D=\pm 0.375$, $Y/D=\pm 0.25$ and $Y/D=\pm 0.125$. Also measurements were taken at longitudinal separations of $X/D=0.46$ and $X/D=0.52$.

For the all movable rudder No. 2 additional longitudinal separations were tested; $X/D=0.30$ and $X/D=0.34$. Also two extra lateral separations were tested; $Y/D=\pm 0.375$. An additional investigation of the effect of lateral separation on rudder No. 2 was carried out at a longitudinal separation of $X/D=0.52$ for four lateral positions $Y/D=\pm 0.25$ and $Y/D=\pm 0.125$.

5. DATA REDUCTION AND CORRECTIONS

5.1 Introduction

A computer program, described in Ref. 1, was used to provide the data in coefficient form. The program incorporates the rudder dynamometer five-component interaction matrix and correction formulae and the resolution of forces and moments from instrument axes to stream axis as necessary. A cross plot of raw rudder data yielded the angular misalignment of the rudder rig and this correction was applied to all measured angles before insertion in the program.

The analysis program incorporates the propeller dynamometer calibrations hence allowing direct calculation of the propeller coefficients.

5.2 Propeller Forces

The dynamic calibration carried out on the Torque-Thrust dynamometer gave a linear response to loading of both thrust and torque with negligible interactions (Ref. 9). It was noted that the calibration constant of the thrust dynamometer had altered. A new value of 9.238N per μv was determined compared with an original 12.28N per μv . It was surmised that this change resulted from the overhaul of the propeller shafting replacement of roller bearings with angular contact ball faces.

Using the relevant wind speed V (m/s) and revolutions n (revs/sec) the advance ratio J is calculated as:

$$J = \frac{V}{nD}$$

where D is propeller diameter. The non-dimensional thrust coefficient (K_T) and torque coefficient (K_Q) are given by:

$$K_T = \frac{T}{\rho n^2 D^4} \quad K_Q = \frac{Q}{\rho n^2 D^5}$$

where ρ is the air density. The propeller efficiency η is:

$$\eta = \left(\frac{J}{2\pi} \right) \times \left(\frac{K_T}{K_Q} \right)$$

5.3 Rudder Forces

For the bollard pull case where the advance ratio $J=0$, the coefficients are non-dimensionalised using $K_T n^2 D^2$ which is based on the theoretical velocity at $J=0$. These non-dimensionalised coefficients are designated by C_L^* and C_D^* etc. and are defined as follows:

$$C_L^* = \frac{L}{\frac{1}{2} \rho A K_T n^2 D^2} \quad C_D^* = \frac{d}{\frac{1}{2} \rho A K_T n^2 D^2}$$

$$C_{M_z}^* = \frac{M_z}{\frac{1}{2} \rho A c K_T n^2 D^2} \quad C_{M_x}^* = \frac{M_x}{\frac{1}{2} \rho A S K_T n^2 D^2} \quad C_{M_y}^* = \frac{M_y}{\frac{1}{2} \rho A S K_T n^2 D^2}$$

Where S is the rudder span, c the mean rudder chord, and A the total rudder area ($A=S.c$). The position of the centre of pressure on the rudder in the spanwise and chordwise directions is obtained as follows:

$$CP_c = \left(\frac{M_z}{N} + W \right) \times \frac{100}{c} \quad CP_s = \left(\frac{M_N}{N} - V \right) \times \frac{100}{S}$$

Where W is the distance of the dynamometer rudder stock from the leading edge and V the distance from the dynamometer measurement centre to the rudder root.

In comparing the propulsive effect of the two rudders, two effective propeller thrust coefficients are defined. The net thrust of the propeller and rudder combination $K_{T(R+P)}$ is defined as:

$$K_{T(R+P)} = K_T - K_D$$

and the net thrust excluding the free-stream drag of the rudder $K_{T(st)}$ defined as:

$$K_{T(st)} = K_T - (K_D - K_{D0})$$

where K_D is the drag of the rudder and K_{D0} the free-stream drag of the rudder. K_D is defined as:

$$K_D = \frac{d}{\rho n^2 D^4} = \frac{1}{2} \frac{A}{D^2} J^2 C_D$$

Useful measures of the performance of rudders are its lift curve slope at zero incidence $dC_L/d\alpha$ and the corresponding drag at zero incidence C_{D0} . These values are obtained directly from the rudder performance data.

6. PRESENTATION OF DATA

The notation of rudder incidence and coefficients used in the presentation is given in Figure 5. The propeller rotates in an anti-clockwise direction when viewed from aft as shown in the diagram.

The main types of graphical presentation used in this report are:

1) Rudder performance

Rudder sideforce, drag, CP_c and CP_s are plotted against rudder incidence. Lift and drag are always perpendicular and parallel to the ship axis even for cases where a drift angle is imposed on the bodies.

2) Propeller performance

Propeller thrust and torque are plotted against rudder angle.

Additional forms of presentation are described within the discussion.

7. DISCUSSION OF RESULTS

7.1 Parameters which Control Rudder-Propeller Interaction

In investigating the various independent parameters on which rudder forces depend, an underlying understanding of the physics of the flow of an isolated rudder and propeller should be obtained. This understanding then gives guidance when addressing the cumulative problem of a rudder and propeller combination. Free surface effects and cavitation are not considered primary in determining the operating conditions of the rudder and propeller combination and were not investigated in this study.

In discussing the parameters which govern the interaction it is convenient to group them into four categories. These are discussed in Ref. 2 and can be summarised briefly as:

i) Flow variables which control the magnitude of the forces developed:

Time dependent variable propeller rate of revolution (n). Fluid properties density (ρ) and dynamic viscosity (μ). The yaw angle (β) between the rudder-propeller combination and the free stream.

ii) Rudder geometric variables:

Rudder incidence (α), span (S), mean chord (c), stock position (W), thickness (t), section shape, sweep and twist.

iii) Propeller geometric variables:

Diameter (D), pitch (P), boss diameter, sweep, pitch and thickness distributions, number of blades and blade area ratio.

iv) Relative position and size of the rudder and propeller.

separation longitudinally (X), laterally (Y) and vertically (Z) and the relative size defined by the coverage ξ .

The flow parameters in non-dimensional form become Advance Ratio, J . The remaining three categories consist of solely geometric parameters. Figure 5 illustrates the geometry of a rudder-propeller combination and corresponds to the arrangement used.

7.2 Influence of Propeller on Rudder Performance

7.2.1 Propeller revolutions

Figures 10 and 11 show the changes in sideforce, drag and centres of pressure at zero J , for the all-movable rudder No. 2 and skeg-rudder No. 0 respectively. The graphs are presented for two rates of propeller revolutions. Increasing the propeller rpm between 1160 and 1460 does not have any significant effect on rudder lift and drag coefficients or centres of pressures. A small stall angle difference is experienced between the two propeller rates of revolution on all-movable rudder No. 2 at higher angles of incidence (Figure 10). This effect is likely to do with the higher propeller rpm of 1460 causing slightly more unsteady flow which, in general, tends to keep the flow attached to the rudder thus preventing stall. All subsequent results are presented for 1460rpm only.

7.2.2 Rudder Types

Figures 10 and 11 show that lift and drag for the all-movable rudder No. 2 is generally higher than the skeg-rudder No. 0. Chordwise centre of pressure is further forward towards the leading edge on the all-movable rudder and spanwise centre of pressure is higher. This is due to the rudder taper on the skeg-rudder No. 0 and also the fact that the skeg-rudder is a split configuration where the root section of the leading edge of the rudder does not have an angle of attack with respect to the flow.

7.3 Influence of Longitudinal Separation on Rudder Performance

Figures 12 to 16 show for 1460rpm the effect of longitudinal separation on all-movable rudder No. 2 and Figures 17 to 19 show the effect for skeg-rudder No. 0. There is very little change in lift curve slope with separation. Drag is reduced with increasing separation and for an X/D greater than 0.34 a thrust is generated at zero incidence. This phenomenon can be seen in Figure 16 and Figure 19 for the all-movable and skeg-rudder respectively. A thrust at an X/D greater than 0.39 is exhibited by both rudder types and is consistent with previously reported results (Ref. 1).

7.4 Influence of Lateral Separation on Rudder Performance

Figures 20 to 26 show the influence of Y/D on all-movable rudder No. 2 in the base longitudinal position of $X/D=0.39$. Lateral positions of $Y/D=\pm 0.375$ show a marked reduction in lift curve slope once the position of the rudder is greater than a Y/D of ± 0.25 . In general drag is higher for values of lateral positions outside of $Y/D=0$.

Figure 26 shows lift and drag at zero incidence for varying lateral position Y/D . The lift offset produced at zero incidence is due to the propeller race rotating. This causes a shift of the zero lift position with respect to rudder incidence. It should be noted that once the lateral position of the rudder is greater than ± 0.25 of the diameter of the propeller the lift offset begins to level off. This is due to the rudder being pulled outside the main governing part of the propeller race. Drag shows similar trends to that of lift with increasing drag up to a $Y/D=\pm 0.25$ and it decreases once the rudder is outside the main proportion of the propeller race. An interesting feature to note is if the rudder is in the mid-lateral position there is thrust experienced on the rudder although the magnitude of this thrust is relatively small.

Figures 27 to 31 show the influence of Y/D on the all-movable rudder No. 2 at a longitudinal position of $X/D=0.52$. The same trends are indicated by this case as for the base longitudinal position $X/D=0.39$. This concludes that a similar tendency for lift and drag on the rudder due to the influence of lateral position is shown for varying longitudinal position.

Figures 32 to 38 show the influence of lateral position Y/D on skeg-rudder No. 0. The results obtained indicate the same trends as that for the all-movable rudder No. 2.

7.5 Influence of Rudder on Propeller Thrust Loading.

Figures 40 and 41 show effect of the all-movable rudder No. 2 and skeg-rudder No. 0 on propeller performance at zero advance ratio ($J=0$) respectively. Propeller thrust (K_T) and Torque (K_Q) remain reasonably constant over the range of rudder angles. There is a thrust and torque augment on the propeller compared to the open water performance presented in Figure 39. Values for K_T and K_Q are greater than the zero advance ratio open water propeller performance.

Figure 41 shows the propeller thrust and torque for two varying rates of propeller revolutions (1460 and 1160 rpm) in general K_T and K_Q are independent of propeller speed for this case.

8. CONCLUSIONS AND RECOMMENDATIONS

- 8.1 At zero ship speed the accelerating effect of the propeller is clearly demonstrated.
- 8.2 Skeg-rudder and all-movable rudder performance are similar at zero J with slight variations in centres of pressure.
- 8.3 Propeller force data is similar for the two types of rudder with a thrust and torque increase due to the rudder.
- 8.4 In general the behaviour of the rudder performance at zero J over the range of parametric variations (X/D , Y/D etc.) is similar to that experienced at higher advance ratios. The indication that these results provide is that, rudder performance at laboratory zero J test procedure could be used to provide rudder design information at a greatly reduced cost compared with higher advance ratio wind tunnel tests.
- 8.5 The large amount of data presented in this report will provide more resource for low speed ship operation in cases, for example, of restricted seaway operation and manoeuvring in port. It will also provide essential information for development of a rudder design manual and validation of theoretical methods.

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TABLE I: PARTICULARS OF THE TWO RUDDER MODELS

Rudder No.	0 (Skeg Rudder)	2
Chord c mm	667	667
Span S mm	1000	1000
Geometric Aspect Ratio AR_G	3.0	3.0
Taper Ratio C_T/C_R	0.8	1.0
Thickness/ chord Ratio t/c	0.20	0.20
Section	NACA 0020 constant section with square tip	

TABLE II: PROPELLER DETAILS - Modified Wageningen B.4.40 Series

Number of Blades	4
Range of revolutions rpm	0 to 3000
Diameter mm	800
Boss Diameter (max) mm	200
Mean Pitch Ratio	0.95 (set for tests)
Blade Area Ratio	0.4
Rake (deg)	0
Blade thickness ratio t/D	0.050
Sections shape	Based on Wageningen B series
Blade outline shape	Based on Wageningen but with reduced skew

APPENDIX A RUDDER FORCE DATA

Unless otherwise stated X/D=0.39, Y/D=0.0 and Z/D=0.75

RUDDER DYNAMOMETER

ypb1463.rud

1460rpm	Rudder No. 2			J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-50	-0.818	0.748	39.025	51.2745	-0.099	-0.519	0.551
-45	-1.036	0.536	24.867	48.3858	0.057	-0.622	0.413
-40	-0.963	0.445	21.76	43.4018	0.084	-0.564	0.298
-35	-0.875	0.319	21.127	42.6608	0.08	-0.501	0.229
-30	-0.775	0.208	20.084	43.8619	0.077	-0.451	0.17
-25	-0.642	0.124	18.834	35.5263	0.071	-0.326	0.097
-20	-0.539	0.077	19.806	36.6299	0.054	-0.285	0.059
-15	-0.379	0.021	19.342	32.2958	0.04	-0.185	0.026
-10	-0.258	-0.009	22.163	29.9257	0.02	-0.12	0.009
-7.5	-0.212	0.003	28.505	26.3149	0.003	-0.092	0.005
-5	-0.14	-0.016	34.955	13.0903	-0.007	-0.043	-0.007
0	-0.02833	-0.025	287.3173	-433.615	-0.032	0.052333	-0.01467
5	0.093	-0.024	-30.945	137.4618	-0.055	0.143	-0.018
7.5	0.171	-0.003	-10.61	90.6353	-0.069	0.185	-0.006
10	0.226	0.006	-7.451	86.1643	-0.084	0.235	0
15	0.399	0.034	2.328	67.2985	-0.109	0.341	0.02
20	0.49	0.087	2.98	72.7479	-0.132	0.442	0.078
25	0.621	0.153	7.064	67.3694	-0.144	0.51	0.165
30	0.759	0.227	11.892	68.2797	-0.14	0.653	0.192
35	0.908	0.317	15.395	64.6758	-0.135	0.752	0.252
40	1.023	0.403	16.033	62.9078	-0.145	0.808	0.342
45	1.071	0.475	22.306	59.7634	-0.084	0.807	0.387
50	1.202	0.627	24.852	59.1519	-0.064	0.887	0.51

ypb1164.rud

1160rpm	Rudder No. 2			J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.946	0.52	28.008	48.6272	0.02	-0.584	0.385
-40	-0.919	0.388	25.035	46.948	0.047	-0.548	0.303
-35	-0.878	0.311	22.063	45.4447	0.071	-0.528	0.231
-30	-0.714	0.185	18.054	44.2957	0.085	-0.428	0.138
-25	-0.616	0.121	17.279	37.275	0.077	-0.332	0.077
-20	-0.513	0.072	16.716	40.8139	0.067	-0.297	0.048
-15	-0.387	0.047	19.25	31.3836	0.041	-0.189	0.023
-10	-0.219	0.007	21.648	32.2747	0.018	-0.109	0.004
-5	-0.124	-0.018	43.174	5.7007	-0.016	-0.03	-0.022
0	-0.03133	-0.015	-1274.03	1644.628	-0.02567	0.046333	-0.02333
5	0.079	-0.031	-32.562	171.8265	-0.047	0.145	-0.016
10	0.202	0	-6.982	97.8632	-0.074	0.233	0.001
15	0.344	0.037	1.525	77.5432	-0.097	0.329	0.029
20	0.473	0.088	5.619	71.6695	-0.116	0.423	0.077
25	0.6	0.133	9.339	69.0762	-0.124	0.518	0.119
30	0.733	0.2	12.009	68.0214	-0.132	0.619	0.184
35	0.867	0.263	16.421	69.3567	-0.117	0.739	0.249
40	1.017	0.369	19.992	66.6491	-0.102	0.837	0.333

45 0.939 0.479 28.58 59.085 -0.014 0.685 0.401

ypx305.rud
1460rpm

X/D=0.30

Rudder No. 2 J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-1.055	0.62	28.98	49.8689	0.076	-0.664	0.464
-40	-0.929	0.478	27.861	45.7088	0.077	-0.561	0.333
-35	-0.84	0.37	26.251	45.6903	0.082	-0.508	0.266
-30	-0.714	0.257	23.377	39.1158	0.09	-0.39	0.17
-25	-0.637	0.19	25.024	37.5982	0.068	-0.338	0.132
-20	-0.483	0.105	23.459	34.4727	0.058	-0.244	0.073
-15	-0.368	0.078	22.45	38.91	0.049	-0.202	0.064
-10	-0.246	0.045	27.941	24.5254	0.019	-0.1	0.038
-5	-0.103	0.022	40.056	15.4038	-0.005	-0.033	0.021
0	0.00833	0.006333	-48.8557	134.1374	-0.03567	0.068	0.009667
5	0.138	0.004	-8.346	106.1001	-0.06	0.171	0.004
10	0.285	0.018	5.818	83.6561	-0.084	0.289	0.018
15	0.42	0.05	10.457	76.7859	-0.104	0.397	0.043
20	0.547	0.114	11.621	70.2492	-0.131	0.483	0.091
25	0.669	0.177	14.348	69.8905	-0.143	0.586	0.152
30	0.796	0.254	16.56	68.9485	-0.154	0.683	0.228
35	0.961	0.364	20.578	62.8125	-0.147	0.771	0.293
40	1.07	0.477	23	61.2613	-0.139	0.842	0.377
45	1.123	0.585	25.476	57.375	-0.12	0.841	0.438

ypx346.rud
1460rpm

X/D=0.36

Rudder No. 2 J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-1.055	0.613	29.385	50.0369	0.071	-0.682	0.444
-40	-0.94	0.486	27.136	47.861	0.085	-0.595	0.34
-35	-0.816	0.354	25.925	42.3593	0.082	-0.472	0.236
-30	-0.722	0.256	24.368	39.3607	0.083	-0.398	0.168
-25	-0.61	0.178	23.981	37.4898	0.072	-0.325	0.121
-20	-0.492	0.117	23.743	36.8527	0.058	-0.261	0.081
-15	-0.361	0.082	23.145	32.9028	0.045	-0.18	0.048
-10	-0.227	0.046	23.725	34.6042	0.027	-0.116	0.035
-5	0.064	-0.057	76.627	-74.9478	0.028	-0.04	-0.003
0	0.01633	0.009333	37.2313	-120.643	-0.034	0.071667	0.007667
5	0.129	-0.016	-4.416	107.4695	-0.051	0.16	-0.005
10	0.276	0.011	7.628	79.9158	-0.076	0.269	0.006
15	0.384	0.044	5.871	78.5229	-0.113	0.37	0.04
20	0.531	0.107	10.181	69.2247	-0.135	0.465	0.082
25	0.654	0.169	13.514	67.8027	-0.145	0.56	0.14
30	0.769	0.243	17.544	68.911	-0.14	0.667	0.206
35	0.91	0.356	18.395	62.2889	-0.161	0.745	0.258
40	1.002	0.43	20.687	64.1946	-0.153	0.832	0.336
45	1.074	0.579	25.538	56.5839	-0.115	0.833	0.391

ypx467.rud
1460rpm

X/D=0.46

Rudder No. 2 J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-1.111	0.582	30.511	48.3349	0.058	-0.69	0.424
-40	-0.982	0.445	26.93	48.1375	0.088	-0.614	0.329

-35	-0.868	0.313	26.02	43.4707	0.083	-0.51	0.218
-30	-0.777	0.224	24.9	41.2498	0.082	-0.44	0.161
-25	-0.649	0.142	23.391	36.6941	0.078	-0.343	0.097
-20	-0.531	0.069	23.667	38.3187	0.061	-0.288	0.06
-15	-0.356	0.019	21.09	36.1632	0.05	-0.187	0.027
-10	-0.246	-0.006	26.453	26.0493	0.022	-0.106	0.005
-5	-0.13	-0.021	39.394	-0.4062	-0.005	-0.022	-0.002
0	0.01667	-0.04	-1736.61	4055.663	-0.03267	0.079	-0.02133
5	0.145	-0.046	-5.414	91.6899	-0.057	0.157	-0.03
10	0.277	-0.03	3.912	83.789	-0.084	0.278	-0.012
15	0.43	-0.004	9.324	75.7268	-0.108	0.397	0.011
20	0.552	0.052	9.906	68.9377	-0.137	0.475	0.053
25	0.663	0.123	13.128	66.8446	-0.145	0.557	0.108
30	0.799	0.218	16.984	63.7768	-0.147	0.655	0.167
35	0.901	0.294	19.084	63.891	-0.148	0.741	0.227
40	1.049	0.4	22.047	60.6696	-0.141	0.82	0.313
45	1.101	0.513	25.467	62.6387	-0.113	0.883	0.41

ypx528.rud

X/D=0.52

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-1.087	0.601	30.305	46.0918	0.061	-0.674	0.4
-40	-0.998	0.456	27.499	46.7931	0.083	-0.616	0.323
-35	-0.858	0.327	26.322	42.5804	0.081	-0.505	0.212
-30	-0.756	0.223	23.221	38.3111	0.093	-0.415	0.137
-25	-0.597	0.137	20.565	34.7845	0.089	-0.308	0.081
-20	-0.489	0.073	24.355	32.0112	0.053	-0.238	0.046
-15	-0.35	0.028	23.761	25.0469	0.04	-0.149	0.01
-10	-0.21	0.003	23.19	14.2823	0.025	-0.067	-0.002
-5	-0.106	-0.023	37.144	-12.843	-0.002	-0.006	-0.014
0	0.01033	-0.04267	-0.8353	26.8739	-0.032	0.090667	-0.02967
5	0.128	-0.052	-11.552	127.2665	-0.058	0.183	-0.038
10	0.293	-0.037	5.273	80.4396	-0.085	0.285	-0.021
15	0.398	0.01	6.352	76.1375	-0.112	0.372	0.01
20	0.538	0.065	9.6	66.3526	-0.136	0.451	0.056
25	0.662	0.122	12.371	69.1192	-0.15	0.572	0.108
30	0.785	0.203	15.949	66.1373	-0.152	0.659	0.166
35	0.915	0.295	20.279	62.1423	-0.139	0.737	0.224
40	1.021	0.398	21.963	64.8539	-0.139	0.853	0.314
45	1.079	0.484	26.303	60.6971	-0.1	0.827	0.395

ypym110.rud

Y/D=-0.125

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.898	0.628	39.531	48.2427	-0.045	-0.553	0.45
-40	-0.824	0.487	34.209	45.9621	0.011	-0.53	0.301
-35	-0.7	0.324	28.93	46.4341	0.049	-0.439	0.219
-30	-0.676	0.257	26.313	37.4961	0.065	-0.366	0.151
-25	-0.255	0.26	94.793	31.6287	-0.202	-0.184	0.001
-20	-0.431	0.116	15.275	29.353	0.089	-0.198	0.064
-15	-0.274	0.064	8.314	25.721	0.076	-0.116	0.038
-10	-0.149	0.052	-18.245	3.5558	0.083	-0.029	0.027
-5	-0.013	0.038	-396.171	-227.287	0.068	0.036	0.027

0	0.10733	0.037	79.5297	123.2869	0.045667	0.145333	0.021
5	0.251	0.033	41.655	75.2153	0.016	0.233	0.025
10	0.345	0.065	29.271	69.0654	-0.021	0.3	0.045
15	0.457	0.101	23.165	66.3946	-0.057	0.388	0.069
20	0.546	0.155	19.588	63.4217	-0.089	0.446	0.113
25	0.632	0.217	18.599	64.2698	-0.112	0.525	0.159
30	0.673	0.287	22.109	60.098	-0.096	0.531	0.208
35	0.711	0.358	24.638	60.8439	-0.085	0.565	0.269
40	0.774	0.474	26.146	62.1269	-0.083	0.621	0.372
45	0.764	0.58	29.541	60.9245	-0.056	0.595	0.459

ypym211.rud

Y/D=-0.25

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.697	0.562	49.271	42.5322	-0.124	-0.399	0.356
-40	-0.642	0.423	45.972	40.7597	-0.081	-0.353	0.271
-35	-0.552	0.275	40.037	42.9786	-0.028	-0.327	0.176
-30	-0.527	0.19	33.4	33.6321	0.011	-0.261	0.111
-25	-0.4	0.12	26.072	30.284	0.038	-0.185	0.07
-20	-0.287	0.071	12.315	23.0696	0.068	-0.112	0.041
-15	-0.159	0.079	24.435	-1.479	0.019	-0.019	0.036
-10	-0.065	0.038	-109.359	-19.0371	0.102	0.006	0.027
-5	0.067	0.036	167.723	96.1579	0.084	0.074	0.023
0	0.18867	0.038667	73.1217	71.5487	0.071667	0.168333	0.025667
5	0.291	0.055	50.632	76.9945	0.045	0.276	0.033
10	0.428	0.081	38.271	65.9398	0.013	0.36	0.054
15	0.555	0.114	31.574	61.6928	-0.022	0.442	0.08
20	0.631	0.157	25.457	57.8408	-0.064	0.479	0.108
25	0.712	0.21	23.828	61.3689	-0.085	0.567	0.154
30	0.797	0.287	22.328	59.7512	-0.109	0.624	0.207
35	0.887	0.385	22.047	55.1218	-0.126	0.667	0.247
40	0.909	0.439	20.898	54.7521	-0.142	0.667	0.305
45	0.906	0.479	21.411	56.6287	-0.137	0.667	0.36

ypym312.rud

Y/D=-0.375

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.437	0.356	86.944	50.1241	-0.289	-0.3	0.236
-40	-0.404	0.26	83.843	47.3729	-0.231	-0.261	0.169
-35	-0.379	0.197	73.791	44.9063	-0.163	-0.231	0.13
-30	-0.333	0.14	67.843	33.9435	-0.116	-0.168	0.078
-25	-0.231	0.08	55.778	32.4967	-0.05	-0.113	0.045
-20	-0.145	0.031	19.248	21.4808	0.024	-0.054	0.018
-15	-0.054	0.018	-66.977	-9.4754	0.058	-0.002	0.011
-10	0.044	0.016	217.755	116.2309	0.074	0.056	0.005
-5	0.146	0.017	92.517	61.7177	0.082	0.115	0.006
0	0.19833	0.025	75.456	64.9669	0.079667	0.163333	0.013667
5	0.264	0.037	61.806	61.3612	0.07	0.209	0.023
10	0.311	0.052	50.118	61.9956	0.046	0.247	0.041
15	0.389	0.079	38.91	57.0709	0.014	0.291	0.056
20	0.449	0.106	31.349	59.2246	-0.018	0.345	0.08
25	0.535	0.146	28.209	55.6284	-0.039	0.392	0.105
30	0.589	0.187	23.764	60.5337	-0.07	0.462	0.141

35	0.686	0.248	23.193	53.7704	-0.086	0.493	0.171
40	0.748	0.304	20.61	53.434	-0.113	0.538	0.207
45	0.764	0.58	29.541	60.9245	-0.056	0.595	0.459

ypyp113.rud

Y/D=+0.125

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.78	0.659	36.871	47.762	-0.015	-0.482	0.457
-40	-0.779	0.502	30.402	47.0498	0.046	-0.48	0.352
-35	-0.734	0.386	29.587	43.3823	0.048	-0.434	0.254
-30	-0.654	0.259	27.524	43.3882	0.055	-0.384	0.183
-25	-0.549	0.184	27.598	46.0268	0.045	-0.342	0.132
-20	-0.522	0.147	31.741	39.327	0.02	-0.291	0.097
-15	-0.427	0.098	33.542	36.6032	0.008	-0.229	0.061
-10	-0.326	0.079	41.513	47.821	-0.021	-0.212	0.058
-5	-0.222	0.062	61.519	38.2145	-0.059	-0.123	0.04
0	-0.10967	0.029	114.041	-6.8048	-0.08133	-0.01267	0.023
5	0.015	0.019	-632.498	627.4944	-0.108	0.103	0.018
10	0.185	0.031	-29.628	103.0371	-0.122	0.223	0.032
15	0.338	0.077	-5.151	76.0801	-0.14	0.318	0.064
20	0.485	0.128	7.267	70.7913	-0.14	0.43	0.108
25	0.605	0.189	14.102	68.5947	-0.134	0.522	0.161
30	0.751	0.277	20.117	65.1955	-0.12	0.623	0.225
35	0.893	0.391	26.473	60.5682	-0.085	0.704	0.295
40	0.99	0.438	31.192	59.2263	-0.044	0.764	0.331
45	1.062	0.608	34.414	58.1433	-0.011	0.817	0.447

ypyp214.rud

Y/D=+0.25

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.847	0.505	21.138	51.9278	0.136	-0.556	0.383
-40	-0.812	0.397	22.16	52.9986	0.116	-0.549	0.307
-35	-0.748	0.345	24.499	45.0406	0.088	-0.449	0.242
-30	-0.675	0.268	25.457	52.663	0.071	-0.459	0.213
-25	-0.663	0.209	30.911	50.639	0.031	-0.441	0.165
-20	-0.606	0.162	32.81	41.5161	0.016	-0.352	0.113
-15	-0.477	0.119	40.689	47.8276	-0.026	-0.31	0.083
-10	-0.4	0.088	46.625	38.0575	-0.046	-0.22	0.061
-5	-0.3	0.072	60.366	42.1889	-0.076	-0.179	0.045
0	-0.21067	0.042	79.9507	32.4303	-0.09367	-0.10533	0.031
5	-0.083	0.017	175.299	-36.851	-0.113	0.014	0.021
10	0.049	0.027	-178.958	203.0987	-0.113	0.113	0.031
15	0.191	0.058	-22.256	91.0595	-0.115	0.209	0.055
20	0.336	0.089	6.598	78.1983	-0.1	0.32	0.089
25	0.484	0.159	23.035	68.448	-0.062	0.416	0.136
30	0.612	0.245	32.819	66.9694	-0.017	0.519	0.204
35	0.738	0.343	40.244	62.9251	0.039	0.599	0.268
40	0.826	0.391	43.942	62.9848	0.076	0.665	0.314
45	0.76	0.624	52.794	56.374	0.17	0.555	0.467

ypyp315.rud

Y/D=+0.375

1460rpm

Rudder No. 2

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
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-45	-0.737	0.374	22.879	57.7866	0.098	-0.526	0.311
-40	-0.749	0.295	22.696	52.2171	0.097	-0.495	0.238
-35	-0.718	0.237	24.498	47.2117	0.079	-0.444	0.183
-30	-0.63	0.192	28.282	50.3218	0.046	-0.41	0.16
-25	-0.535	0.148	33.132	50.2128	0.012	-0.35	0.127
-20	-0.507	0.122	38.479	46.4696	-0.016	-0.316	0.101
-15	-0.409	0.084	47.258	44.931	-0.05	-0.251	0.069
-10	-0.359	0.058	53.605	42.7151	-0.066	-0.214	0.049
-5	-0.275	0.043	68.253	49.3294	-0.091	-0.184	0.029
0	-0.239	0.021667	78.063	38.0903	-0.10167	-0.13233	0.019
5	-0.147	0	105.857	24.4807	-0.103	-0.062	0.01
10	-0.056	-0.004	165.322	-45.5548	-0.072	0.014	0.013
15	0.041	0.005	-99.498	203.8862	-0.055	0.087	0.026
20	0.165	0.022	23.068	94.7868	-0.02	0.177	0.048
25	0.286	0.086	49.194	77.1707	0.041	0.265	0.094
30	0.431	0.149	59.935	66.8474	0.11	0.352	0.146
35	0.524	0.254	65.385	66.2947	0.173	0.433	0.222
40	0.617	0.35	68.849	59.9532	0.233	0.465	0.286
45	0.663	0.451	67.551	58.1972	0.254	0.483	0.36

ypxym116.rud		X/D=0.52			Y/D=-0.125		
1460rpm		Rudder No. 2			J=0		
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.765	0.569	43.297	46.3261	-0.075	-0.449	0.403
-40	-0.867	0.421	35.804	45.6388	-0.004	-0.501	0.321
-35	-0.83	0.308	29.889	40.9627	0.047	-0.465	0.209
-30	-0.713	0.214	24.61	39.9496	0.078	-0.397	0.144
-25	-0.595	0.141	21.421	36.4826	0.084	-0.313	0.094
-20	-0.441	0.085	16.78	31.2843	0.083	-0.21	0.056
-15	-0.283	0.029	6.452	24.3908	0.081	-0.115	0.024
-10	-0.143	0.004	-28.134	13.3053	0.09	-0.042	0.012
-5	-0.009	-0.004	-813.381	-349.597	0.07	0.028	0.011
0	0.109	-0.00467	80.3643	108.7061	0.048	0.136333	0.006667
5	0.21	0.015	45.277	89.3239	0.021	0.225	0.013
10	0.343	0.046	30.107	70.7168	-0.018	0.304	0.031
15	0.41	0.069	21.928	70.7442	-0.056	0.363	0.055
20	0.499	0.128	16.886	66.3572	-0.095	0.426	0.087
25	0.577	0.195	17.171	64.6153	-0.11	0.486	0.133
30	0.629	0.255	19.495	60.7194	-0.107	0.497	0.191
35	0.702	0.34	22.171	62.0471	-0.102	0.559	0.27
40	0.703	0.447	25.516	59.342	-0.081	0.56	0.319
45	0.708	0.568	28.473	58.7978	-0.062	0.543	0.43

ypxym217.rud		X/D=0.52			Y/D=-0.25		
1460rpm		Rudder No. 2			J=0		
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.706	0.543	51.618	46.1431	-0.143	-0.416	0.379
-40	-0.618	0.403	49.291	38.4762	-0.102	-0.326	0.249
-35	-0.583	0.274	43.624	35.2197	-0.052	-0.291	0.167
-30	-0.522	0.181	36.51	33.2178	-0.006	-0.258	0.103
-25	-0.419	0.128	30.798	33.2519	0.02	-0.207	0.078
-20	-0.282	0.068	12.369	32.2137	0.066	-0.137	0.043
-15	-0.159	0.03	-24.049	20.871	0.096	-0.058	0.022

-10	-0.031	0.014	-266.804	-97.8525	0.101	0.029	0.009
-5	0.066	0.018	174.592	96.7536	0.089	0.075	0.016
0	0.224	0.039	72.0757	50.2407	0.076333	0.126333	0.023333
5	0.295	0.041	53.44	65.7445	0.054	0.245	0.031
10	0.419	0.078	39.94	62.8247	0.019	0.339	0.05
15	0.502	0.113	31.494	63.0425	-0.02	0.408	0.075
20	0.593	0.147	26.996	60.4971	-0.051	0.466	0.105
25	0.685	0.221	22.471	60.4803	-0.092	0.546	0.147
30	0.775	0.288	20.672	56.1786	-0.12	0.585	0.187
35	0.813	0.391	22.085	52.7331	-0.118	0.595	0.24
40	0.816	0.435	20.182	54.898	-0.138	0.623	0.277
45	0.793	0.504	23.361	56.4245	-0.11	0.619	0.34

ypxyp118.rud		X/D=0.52			Y/D=+0.125		
1460rpm		Rudder No. 2		J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.78	0.633	39.809	46.4377	-0.044	-0.465	0.438
-40	-0.768	0.547	38.601	42.9996	-0.03	-0.441	0.359
-35	-0.708	0.378	30.43	45.5596	0.039	-0.434	0.256
-30	-0.638	0.27	29.362	44.7417	0.041	-0.387	0.186
-25	-0.522	0.147	29.841	44.2835	0.03	-0.313	0.111
-20	-0.503	0.116	35.869	41.0172	-0.002	-0.287	0.088
-15	-0.448	0.07	36.278	38.0089	-0.004	-0.245	0.052
-10	-0.347	0.038	43.318	36.9461	-0.028	-0.187	0.034
-5	-0.244	0.014	59.837	35.8734	-0.06	-0.129	0.02
0	-0.119	0.003333	115.4937	0.3982	-0.08967	-0.023	0.009667
5	-0.006	-0.007	1772.906	-1088.42	-0.123	0.075	0.008
10	0.144	-0.005	-60.074	114.9533	-0.135	0.188	0.007
15	0.304	0.049	-14.086	77.6451	-0.152	0.29	0.045
20	0.444	0.092	0.795	71.4399	-0.155	0.395	0.081
25	0.602	0.166	11.265	64.4329	-0.148	0.496	0.129
30	0.724	0.237	18.876	63.3692	-0.123	0.584	0.193
35	0.876	0.342	26.167	59.6012	-0.084	0.674	0.266
40	0.973	0.448	28.665	62.639	-0.069	0.798	0.337
45	1.015	0.537	32.752	58.3358	-0.029	0.784	0.392

ypxyp219.rud		X/D=0.52			Y/D=+0.25		
1460rpm		Rudder No. 2		J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-45	-0.817	0.523	30.862	47.8276	0.043	-0.48	0.396
-40	-0.846	0.402	23.289	51.4648	0.11	-0.549	0.318
-35	-0.804	0.294	20.427	51.6507	0.124	-0.527	0.244
-30	-0.772	0.3	28.208	48.7465	0.059	-0.497	0.223
-25	-0.696	0.214	32.454	41.3709	0.021	-0.403	0.14
-20	-0.616	0.128	35.288	48.953	0.001	-0.395	0.123
-15	-0.493	0.09	42.446	44.0965	-0.035	-0.3	0.069
-10	-0.417	0.063	49.397	38.4484	-0.059	-0.23	0.053
-5	-0.295	0.041	66.735	40.7905	-0.093	-0.171	0.037
0	-0.20367	0.014	90.9387	25.9191	-0.111	-0.08833	0.021667
5	-0.095	0.007	169.034	-20.0401	-0.126	0.001	0.015
10	0.048	0.008	-236.043	239.1588	-0.131	0.122	0.023
15	0.209	0.035	-26.078	89.4557	-0.129	0.222	0.042
20	0.331	0.071	0.389	77.1912	-0.117	0.311	0.074

25	0.473	0.147	20.286	69.6676	-0.074	0.413	0.126
30	0.607	0.217	29.675	65.6956	-0.036	0.502	0.187
35	0.748	0.323	37.958	59.7725	0.021	0.576	0.252
40	0.879	0.411	41.936	57.8717	0.061	0.66	0.313
45	0.65	0.573	51.071	56.3206	0.136	0.475	0.428

ypsb1420.rud

1460rpm	Rudder No. 0			J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.776	0.273	23.397	33.1601	0.095	-0.394	0.137
-30	-0.663	0.178	21.908	32.3708	0.089	-0.33	0.09
-25	-0.605	0.116	21.631	30.0983	0.082	-0.292	0.045
-20	-0.468	0.058	20.169	29.4149	0.07	-0.222	0.022
-15	-0.301	0.019	16.983	23.9073	0.054	-0.126	0.003
-10	-0.203	-0.011	10.471	9.8676	0.049	-0.056	-0.003
-5	-0.086	-0.037	10.697	-24.0766	0.02	0.004	-0.012
0	0.01567	-0.03467	-477.744	-3589.68	0.014333	0.082667	-0.01733
5	0.133	-0.027	45.992	118.424	0.014	0.18	-0.02
10	0.292	-0.007	33.761	69.6033	-0.005	0.255	-0.008
15	0.399	0.028	33.484	73.1256	-0.007	0.363	0.021
20	0.519	0.079	32.705	62.1568	-0.014	0.417	0.054
25	0.645	0.146	33.079	59.5835	-0.015	0.509	0.086
30	0.762	0.221	33.797	60.6645	-0.012	0.61	0.148
35	0.849	0.297	35.44	60.6542	0	0.689	0.196

ypsym121.rud

Y/D=-0.125

1460rpm	Rudder No. 0			J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.729	0.286	24.532	32.3167	0.083	-0.374	0.127
-30	-0.605	0.201	20.852	30.5477	0.091	-0.293	0.092
-25	-0.487	0.148	17.431	31.4772	0.091	-0.24	0.071
-20	-0.358	0.09	9.399	30.0015	0.095	-0.169	0.046
-15	-0.204	0.043	-8.704	18.9253	0.092	-0.072	0.025
-10	-0.095	0.035	-51.872	-5.5586	0.087	-0.007	0.027
-5	0.027	0.024	335.88	227.1693	0.075	0.063	0.022
0	0.15633	0.032333	72.3053	83.5082	0.057	0.157	0.027333
5	0.288	0.034	48.577	72.3074	0.038	0.259	0.024
10	0.384	0.062	40.067	63.5429	0.018	0.312	0.047
15	0.51	0.101	37	57.1364	0.008	0.383	0.065
20	0.575	0.148	34.297	59.6731	-0.006	0.453	0.088
25	0.658	0.194	34.49	53.1707	-0.006	0.475	0.115
30	0.684	0.259	37.462	56.9257	0.015	0.527	0.162
35	0.657	0.318	41.065	57.7588	0.041	0.523	0.198

ypsym222.rud

Y/D=-0.25

1460rpm	Rudder No. 0			J=0			
Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.605	0.27	32.335	25.4594	0.02	-0.278	0.09
-30	-0.436	0.167	25.6	17.4889	0.045	-0.167	0.034
-25	-0.361	0.116	16.142	19.0538	0.072	-0.139	0.028
-20	-0.262	0.085	0.363	18.4155	0.096	-0.096	0.024
-15	-0.133	0.054	-44.496	-5.3448	0.114	-0.014	0.015
-10	-0.035	0.05	-222.241	-74.4107	0.11	0.029	0.024

-5	0.107	0.039	127.426	91.4403	0.095	0.115	0.023
0	0.211	0.051333	74.2663	69.5759	0.081667	0.183333	0.028667
5	0.358	0.071	53.208	55.5455	0.065	0.262	0.045
10	0.448	0.11	45.012	55.3573	0.044	0.33	0.06
15	0.545	0.153	39.057	53.4045	0.021	0.392	0.087
20	0.653	0.21	37.748	53.6448	0.016	0.476	0.118
25	0.712	0.252	36.224	51.4532	0.006	0.503	0.149
30	0.778	0.318	34.54	47.7166	-0.007	0.526	0.175
35	0.787	0.401	38.578	49.2117	0.028	0.562	0.215

ypsym323.rud

Y/D=-0.375

1460rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.418	0.165	58.927	16.0246	-0.103	-0.152	0.039
-30	-0.312	0.099	47.667	19.6919	-0.039	-0.121	0.029
-25	-0.2	0.054	31.078	14.7399	0.009	-0.067	0.012
-20	-0.113	0.023	-4.018	-6.7653	0.045	-0.011	0.006
-15	-0.027	0.01	-199.277	-155.791	0.067	0.043	0.008
-10	0.084	-0.003	126.595	89.7077	0.076	0.093	0.009
-5	0.146	-0.002	81.948	72.2523	0.068	0.132	0.014
0	0.21767	0.015667	63.344	58.62	0.060333	0.165333	0.022
5	0.274	0.037	54.348	52.3182	0.052	0.191	0.032
10	0.329	0.066	46.479	52.6846	0.037	0.231	0.045
15	0.408	0.09	38.996	50.9858	0.015	0.28	0.061
20	0.463	0.119	33.168	48.6244	-0.011	0.307	0.075
25	0.535	0.163	31.688	51.5097	-0.02	0.378	0.094
30	0.578	0.209	28.893	44.9732	-0.039	0.378	0.102
35	0.6	0.238	27.838	51.42	-0.047	0.431	0.138

ypsyp124.rud

Y/D=+0.125

1460rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.587	0.31	34.631	37.9852	0.005	-0.337	0.155
-30	-0.578	0.232	35.787	31.214	-0.002	-0.286	0.106
-25	-0.521	0.157	36.855	31.4524	-0.008	-0.248	0.091
-20	-0.462	0.111	35.296	35.6746	0	-0.244	0.062
-15	-0.367	0.07	32.025	32.6871	0.012	-0.181	0.045
-10	-0.298	0.048	36.44	28.5997	-0.003	-0.134	0.041
-5	-0.19	0.017	51.676	21.7268	-0.031	-0.072	0.032
0	-0.08833	0.019333	99.0707	-27.878	-0.05367	0.009	0.024333
5	0.092	0.017	-20.552	90.5596	-0.052	0.099	0.021
10	0.221	0.043	8.658	79.5133	-0.06	0.215	0.036
15	0.363	0.069	20.12	67.3939	-0.056	0.31	0.053
20	0.492	0.119	22.915	64.343	-0.063	0.407	0.084
25	0.595	0.176	26.404	59.8657	-0.055	0.468	0.12
30	0.691	0.249	29.312	60.7966	-0.044	0.557	0.166
35	0.8	0.315	33.35	58.3663	-0.017	0.625	0.213

ypsyp225.rud

Y/D=+0.25

1460rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.596	0.392	36.549	40.0443	-0.008	-0.352	0.213
-30	-0.604	0.294	30.241	40.391	0.034	-0.358	0.155

-25	-0.558	0.197	31.969	36.1374	0.02	-0.296	0.113
-20	-0.531	0.152	35.883	33.6246	-0.003	-0.267	0.089
-15	-0.423	0.106	39.661	35.1676	-0.019	-0.22	0.066
-10	-0.365	0.069	40.923	39.061	-0.021	-0.204	0.052
-5	-0.29	0.052	51.89	34.0926	-0.048	-0.148	0.043
0	-0.18025	0.036	69.9052	22.0624	-0.06175	-0.07175	0.031
5	-0.083	0.033	115.245	-12.9827	-0.064	-0.006	0.025
10	0.053	0.04	-72.449	136.7093	-0.064	0.087	0.032
15	0.202	0.057	4.257	72.6456	-0.065	0.185	0.041
20	0.312	0.091	16.482	67.532	-0.061	0.269	0.067
25	0.421	0.145	27.178	64.6169	-0.036	0.356	0.097
30	0.536	0.198	33.077	63.996	-0.013	0.448	0.14
35	0.663	0.279	39.337	58.1721	0.028	0.517	0.189

ypsyp326.rud

Y/D=+0.375

1460rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.491	0.232	26.392	37.5693	0.048	-0.289	0.101
-30	-0.452	0.157	29.28	41.5469	0.029	-0.268	0.091
-25	-0.375	0.102	31.169	39.4031	0.016	-0.213	0.058
-20	-0.361	0.074	35.33	43.2297	0	-0.218	0.047
-15	-0.367	0.055	39.15	42.5181	-0.014	-0.218	0.042
-10	-0.315	0.028	47.037	47.8431	-0.037	-0.203	0.035
-5	-0.271	0.01	56.702	40.3627	-0.058	-0.155	0.025
0	-0.21133	0.016	66.2847	44.835	-0.06567	-0.132	0.016333
5	-0.094	0.009	102.989	33.1357	-0.063	-0.048	0.008
10	-0.026	0.001	223.821	-45.2899	-0.047	0.006	0.005
15	0.067	0.012	-10.347	106.7705	-0.031	0.085	0.011
20	0.185	0.037	32.918	61.0828	-0.005	0.146	0.029
25	0.295	0.085	47.86	56.6548	0.038	0.223	0.056
30	0.417	0.153	53.022	56.3982	0.077	0.315	0.1
35	0.532	0.262	56.774	49.819	0.125	0.369	0.16

ypsb1127.rud

1160rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-30	-0.637	0.192	23.001	26.1867	0.08	-0.296	0.052
-20	-0.416	0.069	17.502	22.1235	0.074	-0.172	0.008
-10	-0.189	-0.008	13.039	-3.5331	0.041	-0.027	-0.006
-5	-0.079	-0.037	-8.307	-34.9177	0.033	0.011	-0.024
0	0.02633	-0.032	152.6857	459.2785	0.015333	0.086	-0.02733
5	0.127	-0.018	42.133	99.3515	0.008	0.148	-0.014
10	0.274	-0.001	35.578	72.3448	0.001	0.246	-0.003
20	0.496	0.099	32.381	58.7129	-0.015	0.387	0.051
30	0.715	0.243	33.55	56.6614	-0.014	0.556	0.135

ypsx4628.rud

X/D=0.46

1460rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.74	0.293	24.372	48.8344	0.085	-0.538	0.127
-30	-0.604	0.196	21.733	51.3108	0.085	-0.449	0.077
-25	-0.512	-0.001	21.412	54.4654	0.065	-0.356	0.027
-20	-0.399	0.094	19.832	68.0766	0.063	-0.354	0.046

-15	-0.322	0.054	18.649	69.9663	0.054	-0.289	0.02
-10	-0.22	0.022	17.947	87.4145	0.038	-0.232	0.015
-5	-0.048	-0.013	-24.289	255.0789	0.028	-0.128	-0.008
0	0.019	-0.002	168.6247	-1604.35	0.012	-0.07867	-0.002
5	0.153	0.001	35.351	-1.5984	0	0.024	0
10	0.297	0.022	32.495	19.4607	-0.009	0.109	0.011
15	0.422	0.058	30.964	32.9379	-0.019	0.211	0.034
20	0.546	0.121	31.155	31.8757	-0.023	0.266	0.069
25	0.65	0.184	30.91	36.0784	-0.03	0.344	0.108
30	0.766	0.257	31.718	40.0766	-0.029	0.434	0.159
35	0.869	0.345	34.41	42.3214	-0.009	0.523	0.202

ypsx5229.rud

X/D=0.52

1460rpm

Rudder No. 0

J=0

Angle	Cl	Cd	Cpc	Cps	Cmz	Cmx	Cmy
-35	-0.77	0.281	26.257	33.2149	0.072	-0.407	0.118
-30	-0.62	0.146	23.915	32.2445	0.07	-0.313	0.065
-25	-0.508	0.103	22.57	29.2145	0.065	-0.246	0.031
-20	-0.404	0.053	20.027	31.1672	0.061	-0.196	0.027
-15	-0.287	-0.003	19.476	17.5064	0.044	-0.103	-0.01
-10	-0.202	-0.011	19.903	10.0171	0.03	-0.055	-0.002
-5	-0.079	-0.04	17.537	-53.7343	0.013	0.026	-0.021
0	0.03867	-0.05233	74.72	289.2568	0.006	0.099667	-0.027
5	0.164	-0.045	39.677	90.7577	0.007	0.176	-0.028
10	0.302	-0.024	33.803	76.6778	-0.005	0.283	-0.016
15	0.416	0.014	30.154	65.5864	-0.021	0.347	0.006
20	0.522	0.07	29.412	63.0334	-0.031	0.425	0.046
25	0.641	0.141	29.622	59.1911	-0.037	0.502	0.085
30	0.747	0.215	32.384	56.9317	-0.023	0.573	0.13
35	0.875	0.309	33.534	57.0633	-0.017	0.679	0.192

APPENDIX B PROPELLER FORCE DATA

Unless otherwise stated $X/D=0.39$, $Y/D=0.0$ and $Z/D=0.75$

PROPELLER DYNAMOMETER

ypb1463.pro

1460rpm	Rudder No. 2			J=0
Angle	Kt	Kq	Cq	Ct
-50	0.45839	0.05678	0.0299	0.3208
-45	0.44378	0.05507	0.029	0.3106
-40	0.43702	0.05469	0.0288	0.3059
-35	0.44913	0.05512	0.029	0.3144
-30	0.42883	0.05383	0.0283	0.3001
-25	0.43631	0.05448	0.0287	0.3054
-20	0.43025	0.05415	0.0285	0.3011
-15	0.43203	0.05383	0.0283	0.3024
-10	0.42883	0.05405	0.0285	0.3001
-7.5	0.43809	0.05523	0.0291	0.3066
-5	0.43987	0.05549	0.0292	0.3079
0	0.41886	0.05462	0.02873	0.29317
5	0.41672	0.05565	0.0293	0.2917
7.5	0.42277	0.05517	0.0291	0.2959
10	0.42206	0.05544	0.0292	0.2954
15	0.4071	0.05405	0.0285	0.2849
20	0.42456	0.0556	0.0293	0.2972
25	0.42883	0.05576	0.0294	0.3001
30	0.42634	0.05512	0.029	0.2984
35	0.43096	0.0549	0.0289	0.3016
40	0.42705	0.05501	0.029	0.2989
45	0.41244	0.05335	0.0281	0.2887
50	0.40995	0.05266	0.0277	0.2869

ypx305.pro

1460rpm	Rudder No. 2			J=0
Angle	Kt	Kq	Cq	Ct
-45	0.46583	0.05639	0.0297	0.326
-40	0.44038	0.05542	0.0292	0.3082
-35	0.43859	0.05515	0.029	0.307
-30	0.42677	0.0537	0.0283	0.2987
-25	0.42569	0.05305	0.0279	0.2979
-20	0.44971	0.05618	0.0296	0.3148
-15	0.45544	0.05602	0.0295	0.3188
-10	0.44361	0.05526	0.0291	0.3105
-5	0.44182	0.05602	0.0295	0.3092
0	0.42127	0.054957	0.02893	0.29487
5	0.42355	0.05645	0.0297	0.2964
10	0.41136	0.05532	0.0291	0.2879
15	0.4128	0.05532	0.0291	0.2889
20	0.43573	0.05656	0.0298	0.305
25	0.42247	0.05639	0.0297	0.2957
30	0.42856	0.05553	0.0292	0.3
35	0.43859	0.05494	0.0289	0.307
40	0.43286	0.05553	0.0292	0.303

45 0.42103 0.05391 0.0284 0.2947

ypx346.pro
1460rpm

X/D=0.36

Rudder No. 2 J=0

Angle	Kt	Kq	Cq	Ct
-45	0.48971	0.05728	0.0302	0.3428
-40	0.48277	0.05628	0.0296	0.3379
-35	0.46487	0.05477	0.0288	0.3254
-30	0.46344	0.05488	0.0289	0.3244
-25	0.4613	0.05429	0.0286	0.3229
-20	0.46845	0.05531	0.0291	0.3279
-15	0.4706	0.05563	0.0293	0.3294
-10	0.47776	0.05596	0.0295	0.3344
-5	0.46416	0.05472	0.0288	0.3249
0	0.45349	0.054907	0.02893	0.3174
5	0.45199	0.05601	0.0295	0.3164
10	0.45092	0.05542	0.0292	0.3156
15	0.45486	0.0559	0.0294	0.3184
20	0.47024	0.05666	0.0298	0.3291
25	0.47132	0.05606	0.0295	0.3299
30	0.46845	0.05633	0.0297	0.3279
35	0.47525	0.05579	0.0294	0.3326
40	0.45199	0.05461	0.0288	0.3164
45	0.46774	0.05488	0.0289	0.3274

ypx467.pro

X/D=0.46

1460rpm Rudder No. 2 J=0

Angle	Kt	Kq	Cq	Ct
-45	0.47409	0.0578	0.0304	0.3318
-40	0.46198	0.057	0.03	0.3233
-35	0.46234	0.05689	0.03	0.3236
-30	0.46162	0.05726	0.0302	0.3231
-25	0.44987	0.05592	0.0294	0.3149
-20	0.45308	0.05732	0.0302	0.3171
-15	0.45022	0.0571	0.0301	0.3151
-10	0.4545	0.05716	0.0301	0.3181
-5	0.4463	0.05625	0.0296	0.3124
0	0.44346	0.05594	0.02943	0.3104
5	0.43918	0.05619	0.0296	0.3074
10	0.43634	0.05603	0.0295	0.3054
15	0.4317	0.05566	0.0293	0.3022
20	0.44453	0.05651	0.0298	0.3111
25	0.44951	0.05726	0.0302	0.3146
30	0.45414	0.05694	0.03	0.3179
35	0.45272	0.0563	0.0296	0.3169
40	0.45165	0.05555	0.0292	0.3161
45	0.45343	0.05576	0.0294	0.3174

ypx528.pro

X/D=0.52

1460rpm Rudder No. 2 J=0

Angle	Kt	Kq	Cq	Ct
-45	0.53316	0.05771	0.0304	0.3732
-40	0.52809	0.05744	0.0302	0.3696

-35	0.52918	0.05673	0.0299	0.3704
-30	0.52664	0.05679	0.0299	0.3686
-25	0.51723	0.05564	0.0293	0.362
-20	0.51433	0.05614	0.0296	0.36
-15	0.51686	0.05635	0.0297	0.3618
-10	0.51288	0.05614	0.0296	0.359
-5	0.52773	0.05657	0.0298	0.3694
0	0.50914	0.05541	0.02917	0.35637
5	0.50781	0.05619	0.0296	0.3554
10	0.5089	0.05603	0.0295	0.3562
15	0.50854	0.05614	0.0296	0.3559
20	0.52918	0.05777	0.0304	0.3704
25	0.53172	0.05755	0.0303	0.3722
30	0.51614	0.05701	0.03	0.3613
35	0.51577	0.05673	0.0299	0.361
40	0.51831	0.05668	0.0298	0.3628
45	0.52664	0.05652	0.0298	0.3686

ypym110.pro

Y/D=-0.125

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.43268	0.05564	0.0293	0.3028
-40	0.4118	0.05391	0.0284	0.2882
-35	0.41612	0.05348	0.0282	0.2912
-30	0.41108	0.05342	0.0281	0.2877
-25	0.41756	0.0538	0.0283	0.2923
-20	0.42008	0.05369	0.0283	0.294
-15	0.41252	0.0538	0.0283	0.2887
-10	0.41252	0.05413	0.0285	0.2887
-5	0.41324	0.05423	0.0286	0.2892
0	0.42164	0.05488	0.0289	0.2951
5	0.40281	0.0545	0.0287	0.2819
10	0.41756	0.05499	0.029	0.2923
15	0.42008	0.05531	0.0291	0.294
20	0.42152	0.05531	0.0291	0.295
25	0.42224	0.05558	0.0293	0.2955
30	0.428	0.05521	0.0291	0.2996
35	0.42584	0.05499	0.029	0.2981
40	0.43952	0.05521	0.0291	0.3076
45	0.42764	0.05434	0.0286	0.2993

ypym211.pro

Y/D=-0.25

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.45194	0.05259	0.0277	0.3163
-40	0.44725	0.05124	0.027	0.313
-35	0.44978	0.05156	0.0272	0.3148
-30	0.45122	0.05189	0.0273	0.3158
-25	0.44545	0.05319	0.028	0.3118
-20	0.47683	0.05503	0.029	0.3337
-15	0.47142	0.05541	0.0292	0.33
-10	0.46961	0.05459	0.0287	0.3287
-5	0.46673	0.05443	0.0287	0.3267

0	0.46216	0.054897	0.0289	0.32347
5	0.46492	0.05481	0.0289	0.3254
10	0.44509	0.05378	0.0283	0.3115
15	0.45735	0.05405	0.0285	0.3201
20	0.45952	0.05389	0.0284	0.3216
25	0.4642	0.05432	0.0286	0.3249
30	0.4642	0.05454	0.0287	0.3249
35	0.46348	0.05486	0.0289	0.3244
40	0.46637	0.054	0.0284	0.3264
45	0.46168	0.05378	0.0283	0.3231

ypym312.pro

Y/D=-0.375

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.41736	0.0523	0.0275	0.2921
-40	0.41303	0.05392	0.0284	0.2891
-35	0.3986	0.05197	0.0274	0.279
-30	0.41988	0.05468	0.0288	0.2939
-25	0.41122	0.05354	0.0282	0.2878
-20	0.42313	0.0549	0.0289	0.2962
-15	0.42313	0.05409	0.0285	0.2962
-10	0.41627	0.05392	0.0284	0.2914
-5	0.42853	0.05468	0.0288	0.2999
0	0.4218	0.054917	0.02893	0.29523
5	0.41122	0.05441	0.0287	0.2878
10	0.42313	0.05468	0.0288	0.2962
15	0.41627	0.05409	0.0285	0.2914
20	0.41411	0.05409	0.0285	0.2898
25	0.42674	0.05398	0.0284	0.2987
30	0.41447	0.05376	0.0283	0.2901
35	0.4224	0.05392	0.0284	0.2956
40	0.42024	0.05436	0.0286	0.2941
45	0.4509	0.05528	0.0291	0.3156

ypyp113.pro

Y/D=+0.125

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.45097	0.05702	0.03	0.3156
-40	0.44667	0.05686	0.0299	0.3126
-35	0.41578	0.05347	0.0282	0.291
-30	0.42368	0.05422	0.0286	0.2965
-25	0.40322	0.05357	0.0282	0.2822
-20	0.40573	0.0525	0.0276	0.284
-15	0.41578	0.05384	0.0284	0.291
-10	0.42368	0.05503	0.029	0.2965
-5	0.42045	0.05449	0.0287	0.2943
0	0.42213	0.05494	0.02893	0.29547
5	0.41794	0.05541	0.0292	0.2925
10	0.41794	0.05406	0.0285	0.2925
15	0.40573	0.05422	0.0286	0.284
20	0.42153	0.05487	0.0289	0.295
25	0.41363	0.05465	0.0288	0.2895
30	0.41291	0.05481	0.0289	0.289

35	0.41148	0.05433	0.0286	0.288
40	0.39568	0.05158	0.0272	0.2769
45	0.38562	0.05034	0.0265	0.2699

ypyp214.pro

Y/D=+0.25

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.44255	0.05631	0.0296	0.3097
-40	0.44255	0.05647	0.0297	0.3097
-35	0.41122	0.05307	0.0279	0.2878
-30	0.40943	0.05296	0.0279	0.2866
-25	0.41447	0.05415	0.0285	0.2901
-20	0.40546	0.05366	0.0283	0.2838
-15	0.40474	0.0529	0.0279	0.2833
-10	0.40582	0.05377	0.0283	0.284
-5	0.4231	0.0548	0.0289	0.2961
0	0.42358	0.055103	0.02903	0.29647
5	0.42671	0.05501	0.029	0.2987
10	0.42058	0.05458	0.0287	0.2944
15	0.4087	0.05447	0.0287	0.2861
20	0.41951	0.05474	0.0288	0.2936
25	0.42527	0.05512	0.029	0.2976
30	0.41987	0.05442	0.0287	0.2939
35	0.42203	0.0542	0.0285	0.2954
40	0.38242	0.05063	0.0267	0.2677
45	0.37954	0.04928	0.026	0.2656

ypyp315.pro

Y/D=+0.375

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.41398	0.05285	0.0278	0.2898
-40	0.41542	0.05399	0.0284	0.2908
-35	0.41651	0.05486	0.0289	0.2915
-30	0.41074	0.05275	0.0278	0.2875
-25	0.40606	0.05275	0.0278	0.2842
-20	0.40425	0.05318	0.028	0.2829
-15	0.41903	0.05394	0.0284	0.2933
-10	0.42263	0.05388	0.0284	0.2958
-5	0.42911	0.05621	0.0296	0.3003
0	0.42131	0.054947	0.02893	0.2949
5	0.42551	0.05583	0.0294	0.2978
10	0.41794	0.05486	0.0289	0.2925
15	0.41903	0.05513	0.029	0.2933
20	0.42911	0.0554	0.0292	0.3003
25	0.41975	0.0548	0.0289	0.2938
30	0.41362	0.0547	0.0288	0.2895
35	0.39957	0.05155	0.0271	0.2797
40	0.35777	0.04787	0.0252	0.2504
45	0.34084	0.04706	0.0248	0.2386

ypxym116.pro

X/D=0.52

Y/D=-0.125

1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct

-45	0.43084	0.05518	0.0291	0.3015
-40	0.43371	0.05459	0.0287	0.3036
-35	0.44343	0.05496	0.0289	0.3104
-30	0.42507	0.05404	0.0285	0.2975
-25	0.43731	0.05518	0.0291	0.3061
-20	0.41896	0.05448	0.0287	0.2932
-15	0.42723	0.05491	0.0289	0.299
-10	0.42651	0.05513	0.029	0.2985
-5	0.42832	0.05372	0.0283	0.2998
0	0.42327	0.0552	0.02907	0.29627
5	0.41212	0.05442	0.0287	0.2884
10	0.41392	0.05442	0.0287	0.2897
15	0.42219	0.05507	0.029	0.2955
20	0.42759	0.05524	0.0291	0.2993
25	0.42616	0.05491	0.0289	0.2983
30	0.43623	0.05507	0.029	0.3053
35	0.43263	0.05469	0.0288	0.3028
40	0.43947	0.05507	0.029	0.3076
45	0.42832	0.05377	0.0283	0.2998

ypxym217.pro X/D=0.52 Y/D=-0.25

1460rpm	Rudder No. 2			J=0
Angle	Kt	Kq	Cq	Ct
-45	0.44742	0.05673	0.0299	0.3132
-40	0.39807	0.05154	0.0271	0.2786
-35	0.41004	0.05242	0.0276	0.287
-30	0.41621	0.05324	0.028	0.2913
-25	0.42638	0.05482	0.0289	0.2984
-20	0.42166	0.05537	0.0292	0.2951
-15	0.42783	0.05537	0.0292	0.2994
-10	0.43	0.05493	0.0289	0.301
-5	0.43145	0.05586	0.0294	0.302
0	0.42516	0.055457	0.0292	0.29757
5	0.41839	0.05542	0.0292	0.2928
10	0.41694	0.05487	0.0289	0.2918
15	0.42238	0.05444	0.0287	0.2956
20	0.41802	0.05455	0.0287	0.2926
25	0.41948	0.05498	0.029	0.2936
30	0.41875	0.05482	0.0289	0.2931
35	0.43254	0.0552	0.0291	0.3027
40	0.42021	0.05487	0.0289	0.2941
45	0.4213	0.05438	0.0286	0.2949

ypxyp118.pro X/D=0.52 Y/D=+0.125

1460rpm	Rudder No. 2			J=0
Angle	Kt	Kq	Cq	Ct
-45	0.44919	0.05743	0.0302	0.3144
-40	0.46541	0.05818	0.0306	0.3258
-35	0.43694	0.05645	0.0297	0.3058
-30	0.4236	0.05499	0.029	0.2965
-25	0.41927	0.05412	0.0285	0.2935
-20	0.41531	0.05439	0.0286	0.2907
-15	0.42216	0.05515	0.029	0.2955

-10	0.42216	0.05515	0.029	0.2955
-5	0.43081	0.05547	0.0292	0.3015
0	0.42504	0.055437	0.0292	0.29747
5	0.41999	0.05553	0.0292	0.294
10	0.41278	0.0552	0.0291	0.2889
15	0.41602	0.05499	0.029	0.2912
20	0.41495	0.05558	0.0293	0.2904
25	0.42829	0.05585	0.0294	0.2998
30	0.42288	0.05526	0.0291	0.296
35	0.42107	0.05466	0.0288	0.2947
40	0.40557	0.05406	0.0285	0.2839
45	0.39584	0.05157	0.0272	0.2771

ypxyp219.pro		X/D=0.52		Y/D=+0.25
1460rpm	Rudder No. 2		J=0	
Angle	Kt	Kq	Cq	Ct
-45	0.43783	0.05752	0.0303	0.3064
-40	0.43057	0.0567	0.0299	0.3014
-35	0.44074	0.05719	0.0301	0.3085
-30	0.41821	0.05544	0.0292	0.2927
-25	0.40477	0.05358	0.0282	0.2833
-20	0.40985	0.05402	0.0284	0.2869
-15	0.41095	0.05407	0.0285	0.2876
-10	0.41676	0.05468	0.0288	0.2917
-5	0.41676	0.05506	0.029	0.2917
0	0.42693	0.05544	0.02917	0.2988
5	0.42076	0.05582	0.0294	0.2945
10	0.41857	0.05506	0.029	0.293
15	0.41276	0.05435	0.0286	0.2889
20	0.41857	0.05517	0.029	0.293
25	0.41894	0.05528	0.0291	0.2932
30	0.41385	0.05489	0.0289	0.2897
35	0.40658	0.05386	0.0284	0.2846
40	0.39496	0.0526	0.0277	0.2764
45	0.38769	0.05052	0.0266	0.2713

ypsb1420.pro		Rudder No. 0		J=0
1460rpm	Kt	Kq	Cq	Ct
-35	0.43477	0.0548	0.0289	0.3043
-30	0.42969	0.05513	0.029	0.3007
-25	0.44636	0.05633	0.0297	0.3124
-20	0.43404	0.05556	0.0293	0.3038
-15	0.43694	0.05556	0.0293	0.3058
-10	0.42498	0.05546	0.0292	0.2975
-5	0.42969	0.05529	0.0291	0.3007
0	0.42535	0.055307	0.0291	0.2977
5	0.41013	0.05524	0.0291	0.2871
10	0.40361	0.05447	0.0287	0.2825
15	0.41231	0.05458	0.0287	0.2886
20	0.42064	0.05578	0.0294	0.2944
25	0.42137	0.05535	0.0291	0.2949
30	0.42716	0.05567	0.0293	0.299

35 0.41919 0.05469 0.0288 0.2934

ypsym121.pro

Y/D=-0.125

1460rpm

Rudder No. 0

J=0

Angle	Kt	Kq	Cq	Ct
-35	0.43312	0.05494	0.0289	0.3031
-30	0.43093	0.05549	0.0292	0.3016
-25	0.42803	0.05554	0.0292	0.2996
-20	0.44655	0.05663	0.0298	0.3125
-15	0.42839	0.05538	0.0292	0.2998
-10	0.43057	0.05543	0.0292	0.3014
-5	0.42477	0.05538	0.0292	0.2973
0	0.42864	0.05594	0.02947	0.3
5	0.41787	0.05521	0.0291	0.2925
10	0.4186	0.0556	0.0293	0.293
15	0.44038	0.05609	0.0295	0.3082
20	0.42984	0.05565	0.0293	0.3009
25	0.43348	0.05554	0.0292	0.3034
30	0.44437	0.05734	0.0302	0.311
35	0.43638	0.05587	0.0294	0.3054

ypsym222.pro

Y/D=-0.25

1460rpm

Rudder No. 0

J=0

Angle	Kt	Kq	Cq	Ct
-35	0.4236	0.05488	0.0289	0.2965
-30	0.4159	0.05461	0.0288	0.2911
-25	0.41883	0.05527	0.0291	0.2931
-20	0.4269	0.05637	0.0297	0.2988
-15	0.42213	0.05576	0.0294	0.2955
-10	0.43461	0.05593	0.0295	0.3042
-5	0.4236	0.05499	0.029	0.2965
0	0.42923	0.055987	0.02947	0.3004
5	0.40341	0.05422	0.0285	0.2824
10	0.41369	0.05505	0.029	0.2895
15	0.42176	0.05488	0.0289	0.2952
20	0.41736	0.05483	0.0289	0.2921
25	0.41883	0.0551	0.029	0.2931
30	0.41516	0.05483	0.0289	0.2906
35	0.42507	0.05472	0.0288	0.2975

ypsym323.pro

Y/D=-0.375

1460rpm

Rudder No. 0

J=0

Angle	Kt	Kq	Cq	Ct
-35	0.42957	0.05557	0.0293	0.3007
-30	0.43069	0.05574	0.0293	0.3014
-25	0.4451	0.05717	0.0301	0.3115
-20	0.44067	0.05706	0.03	0.3084
-15	0.44326	0.05739	0.0302	0.3102
-10	0.44363	0.05612	0.0296	0.3105
-5	0.42625	0.05574	0.0293	0.2983
0	0.43611	0.05653	0.02977	0.30523
5	0.42699	0.05634	0.0297	0.2989
10	0.41848	0.05596	0.0295	0.2929

15	0.42403	0.05601	0.0295	0.2968
20	0.4244	0.05507	0.029	0.297
25	0.41663	0.05457	0.0287	0.2916
30	0.41997	0.05507	0.029	0.2939
35	0.4207	0.05413	0.0285	0.2945

ypsyp124.pro

Y/D=+0.125

1460rpm	Rudder No. 0			J=0
Angle	Kt	Kq	Cq	Ct
-35	0.44333	0.05533	0.0291	0.3103
-30	0.45006	0.05566	0.0293	0.315
-25	0.44594	0.05566	0.0293	0.3121
-20	0.44108	0.0565	0.0298	0.3087
-15	0.4452	0.05695	0.03	0.3116
-10	0.43136	0.05561	0.0293	0.3019
-5	0.44258	0.05645	0.0297	0.3098
0	0.43722	0.056727	0.02987	0.30603
5	0.42277	0.05589	0.0294	0.2959
10	0.43024	0.05617	0.0296	0.3011
15	0.43212	0.05695	0.03	0.3024
20	0.4224	0.05611	0.0295	0.2956
25	0.44071	0.05695	0.03	0.3085
30	0.43772	0.05639	0.0297	0.3064
35	0.43286	0.05656	0.0298	0.303

ypsyp225.pro

Y/D=+0.25

1460rpm	Rudder No. 0			J=0
Angle	Kt	Kq	Cq	Ct
-35	0.43433	0.05573	0.0293	0.304
-30	0.43321	0.05528	0.0291	0.3032
-25	0.42695	0.05456	0.0287	0.2988
-20	0.4192	0.05506	0.029	0.2934
-15	0.42288	0.05473	0.0288	0.296
-10	0.44909	0.05706	0.03	0.3143
-5	0.43285	0.05578	0.0294	0.303
0	0.43479	0.056295	0.02965	0.3043
5	0.43838	0.05756	0.0303	0.3068
10	0.43321	0.05689	0.03	0.3032
15	0.43174	0.05589	0.0294	0.3022
20	0.44983	0.05689	0.03	0.3148
25	0.44797	0.05722	0.0301	0.3135
30	0.44134	0.05634	0.0297	0.3089
35	0.43691	0.05639	0.0297	0.3058

ypsyp326.pro

Y/D=+0.375

1460rpm	Rudder No. 0			J=0
Angle	Kt	Kq	Cq	Ct
-35	0.42564	0.05613	0.0296	0.2979
-30	0.42116	0.05602	0.0295	0.2948
-25	0.42676	0.05557	0.0293	0.2987
-20	0.42601	0.05579	0.0294	0.2982
-15	0.45657	0.05888	0.031	0.3196
-10	0.43943	0.05792	0.0305	0.3076

-5	0.44986	0.05865	0.0309	0.3149
0	0.43769	0.05718	0.0301	0.30633
5	0.44204	0.05759	0.0303	0.3094
10	0.43868	0.05691	0.03	0.307
15	0.4398	0.05731	0.0302	0.3078
20	0.43421	0.0577	0.0304	0.3039
25	0.44017	0.05725	0.0301	0.3081
30	0.44465	0.05708	0.0301	0.3112
35	0.44502	0.05708	0.0301	0.3115

ypsb1127.pro

1160rpm		Rudder No. 0		J=0
Angle	Kt	Kq	Cq	Ct
-30	0.43857	0.05631	0.0297	0.307
-20	0.44211	0.05728	0.0302	0.3094
-10	0.43561	0.05622	0.0296	0.3049
-5	0.4368	0.05631	0.0297	0.3057
0	0.4364	0.056693	0.02983	0.30543
5	0.45039	0.05711	0.0301	0.3152
10	0.43621	0.05684	0.0299	0.3053
20	0.4433	0.05702	0.03	0.3103
30	0.44921	0.05773	0.0304	0.3144

ypsx4628.pro

X/D=0.46

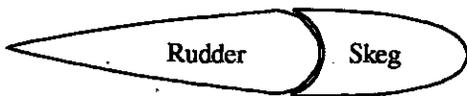
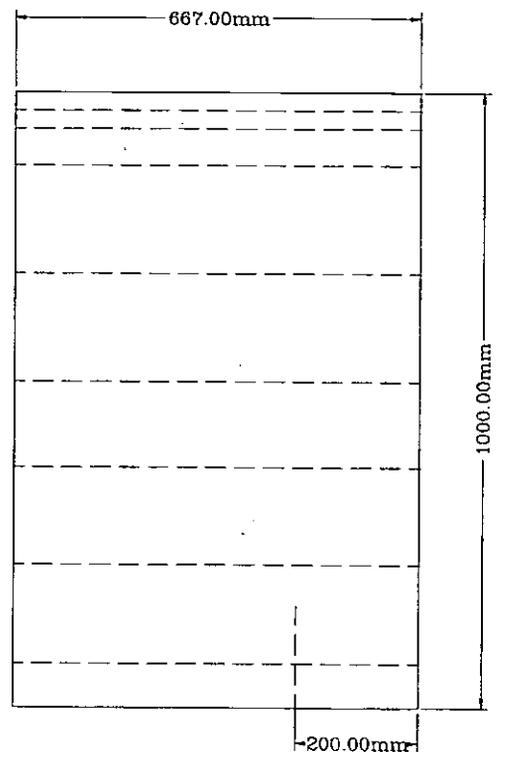
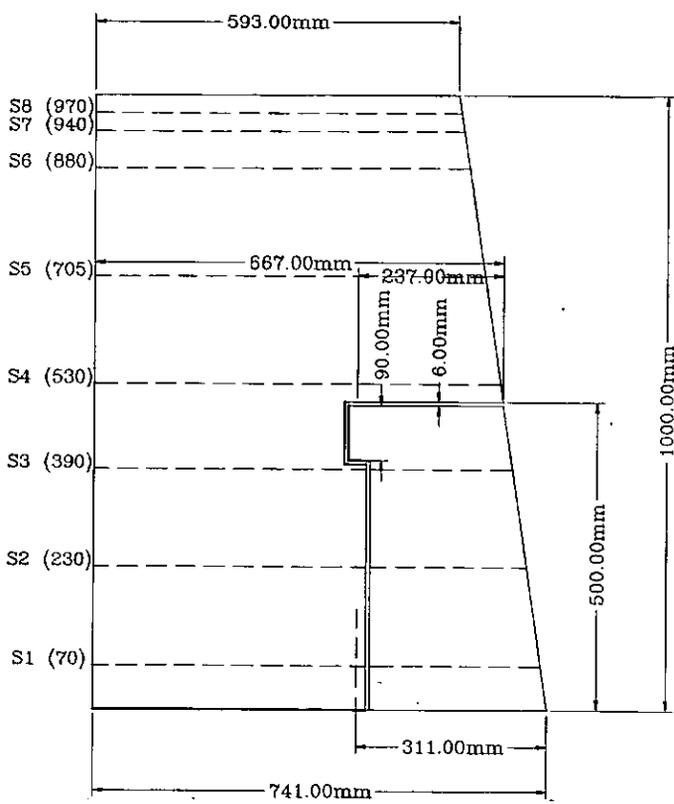
1460rpm		Rudder No. 0		J=0
Angle	Kt	Kq	Cq	Ct
-35	0.4324	0.05609	0.0295	0.3026
-30	0.43578	0.05597	0.0295	0.305
-25	0.42978	0.05575	0.0294	0.3008
-20	0.44329	0.05704	0.03	0.3103
-15	0.42978	0.05592	0.0294	0.3008
-10	0.42752	0.05631	0.0297	0.2992
-5	0.44291	0.05631	0.0297	0.31
0	0.43891	0.057	0.03003	0.30717
5	0.43616	0.05648	0.0297	0.3053
10	0.43014	0.05603	0.0295	0.3011
15	0.4264	0.05569	0.0293	0.2984
20	0.43352	0.05642	0.0297	0.3034
25	0.44779	0.0576	0.0303	0.3134
30	0.43616	0.05704	0.03	0.3053
35	0.4354	0.05715	0.0301	0.3047

ypsx5229.pro

X/D=0.52

1460rpm		Rudder No. 0		J=0
Angle	Kt	Kq	Cq	Ct
-35	0.43738	0.0555	0.0292	0.3061
-30	0.43992	0.0555	0.0292	0.3079
-25	0.4381	0.05583	0.0294	0.3066
-20	0.43485	0.05528	0.0291	0.3044
-15	0.42326	0.05453	0.0287	0.2962
-10	0.44064	0.05566	0.0293	0.3084
-5	0.41566	0.05458	0.0287	0.2909
0	0.427	0.055463	0.0292	0.29883

5	0.41058	0.05539	0.0292	0.2874
10	0.41493	0.05447	0.0287	0.2904
15	0.41602	0.05442	0.0287	0.2912
20	0.42471	0.05599	0.0295	0.2973
25	0.42181	0.05621	0.0296	0.2952
30	0.43557	0.05632	0.0297	0.3049
35	0.42724	0.05523	0.0291	0.299



NACA 0020 Section



NACA 0020 Section

Fig. 1 Dimensions of two rudder models

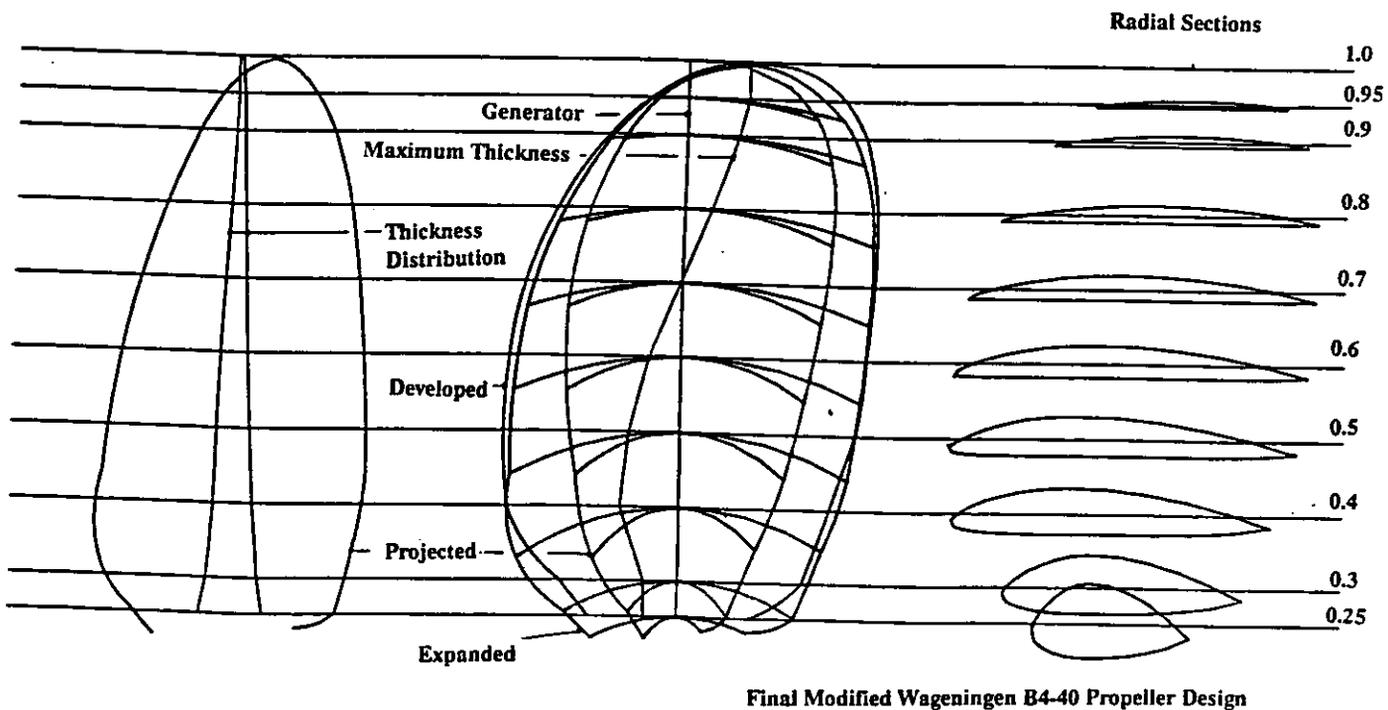
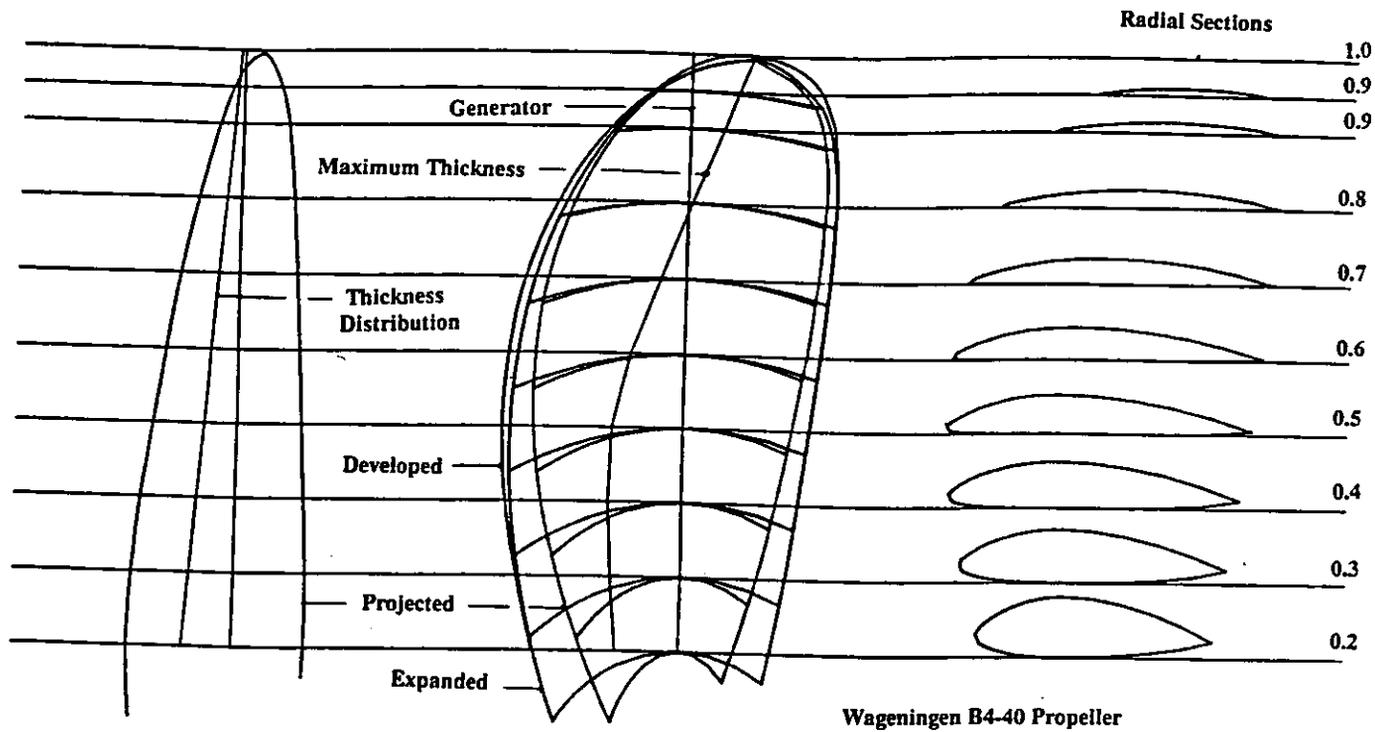
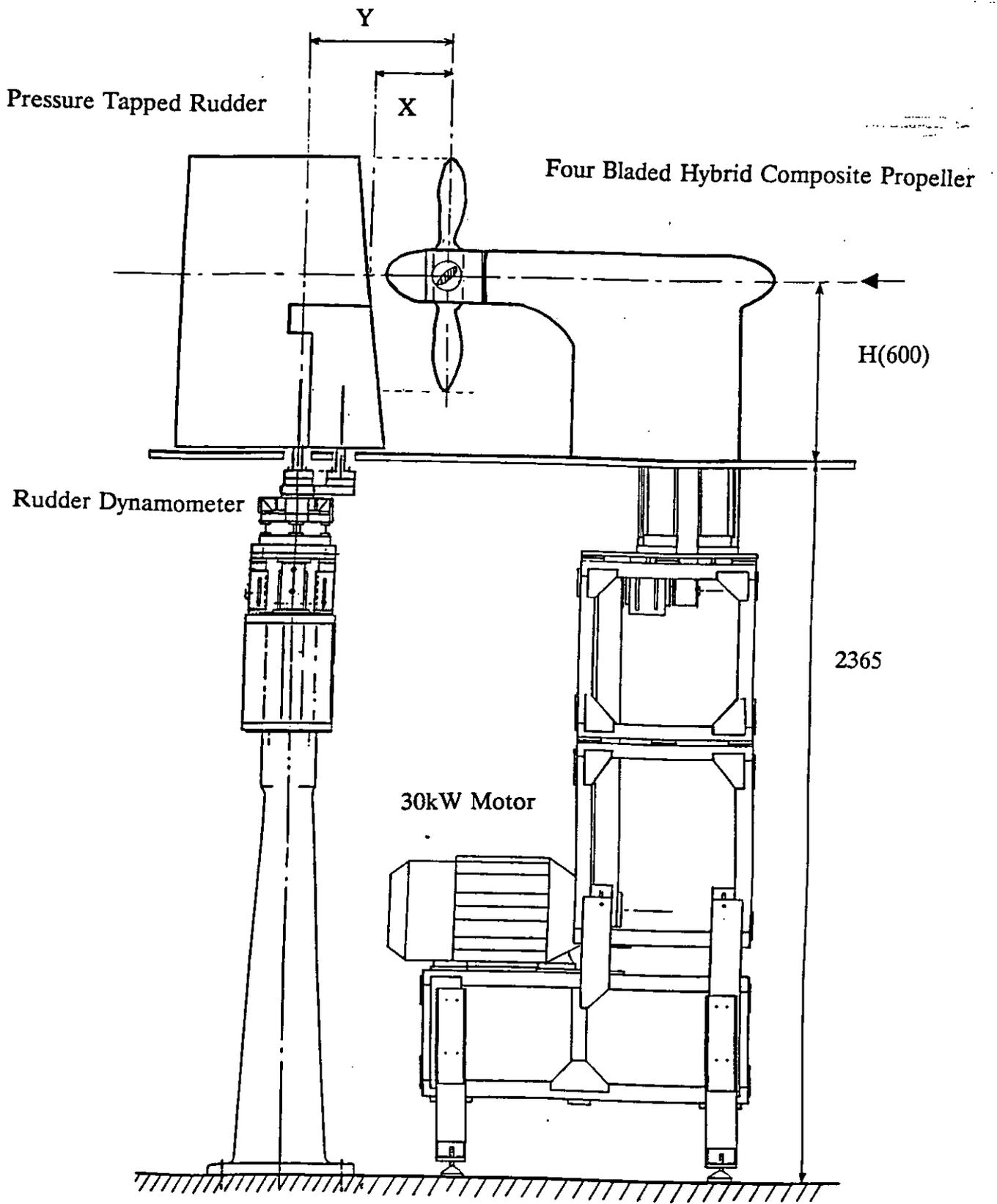


Fig. 2 Comparison of basis and modified Wageningen B.4.40 Propeller

Wag. B4.40



All dimensions in mm

Fig. 3 Overall test rig for investigation of rudder propeller interactions.

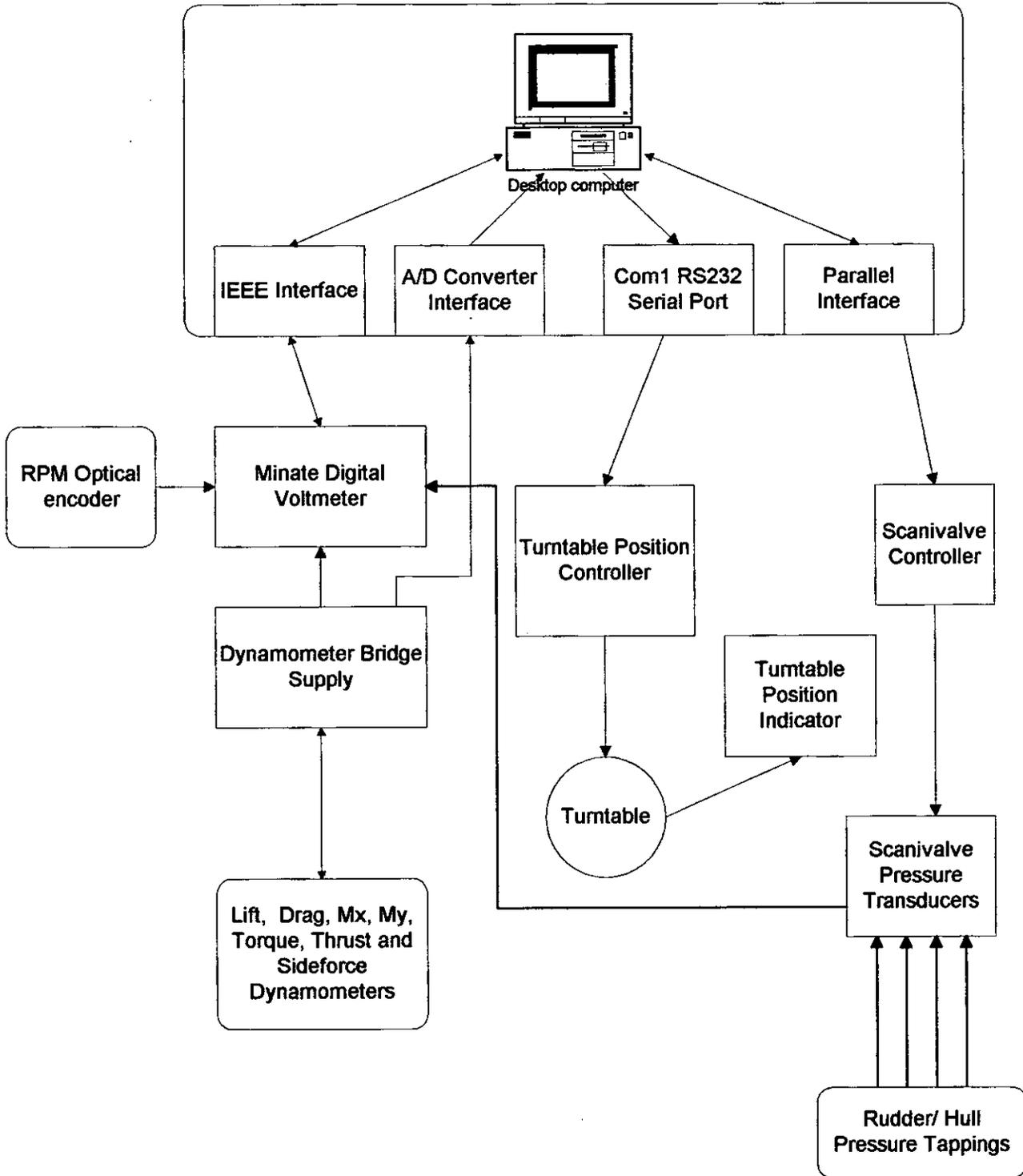


Fig. 4 Rudder and Propeller Control System Schematic

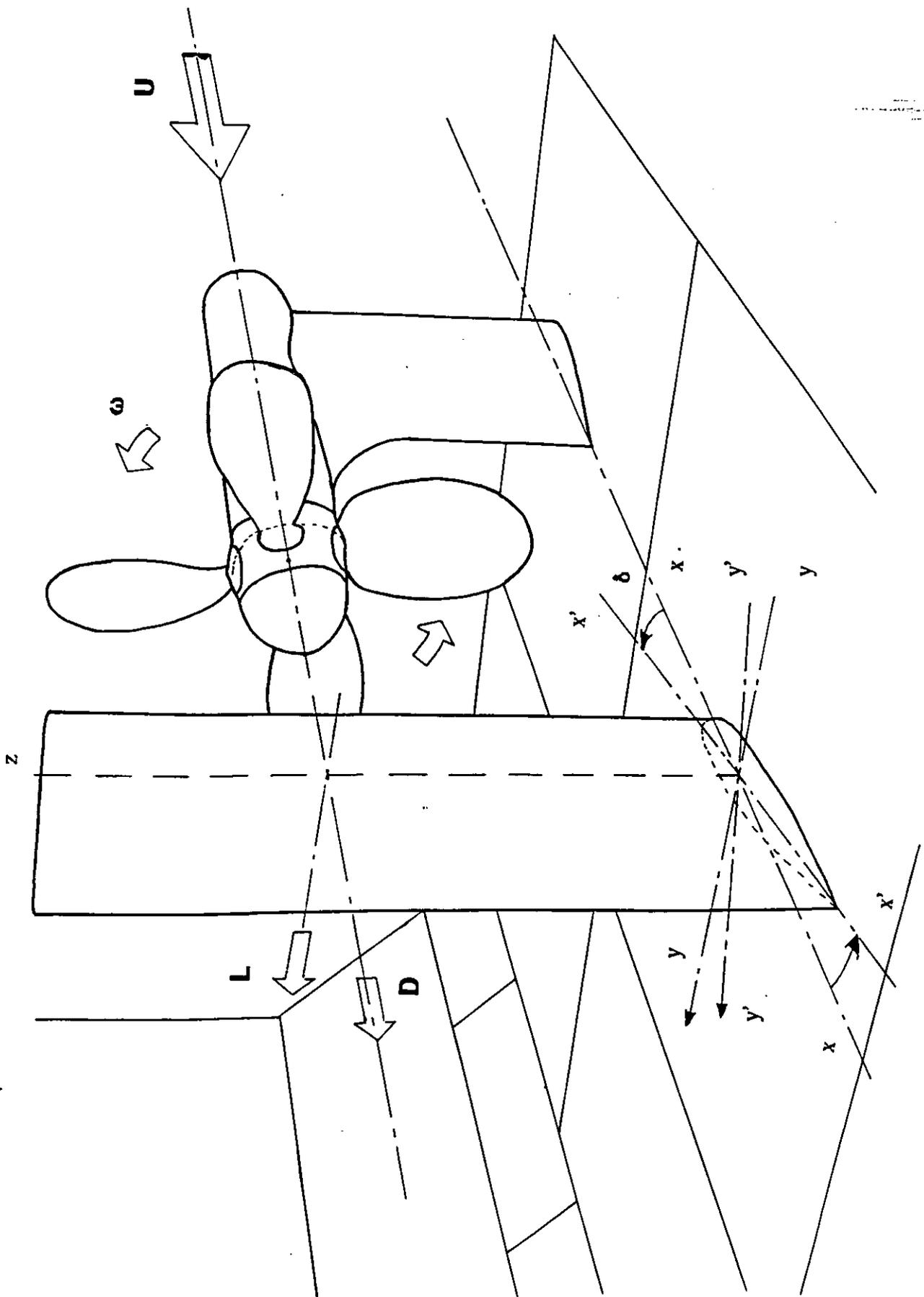
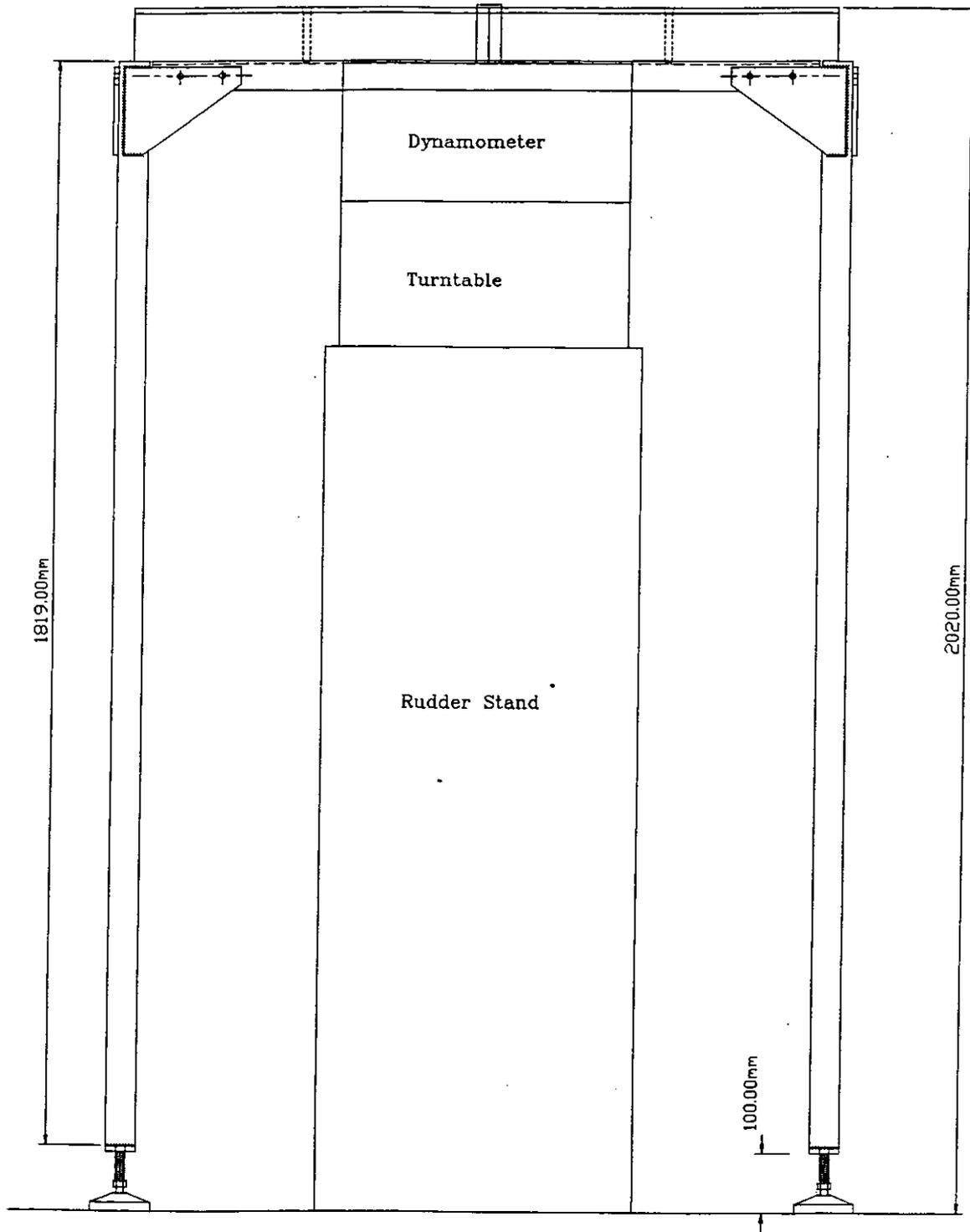
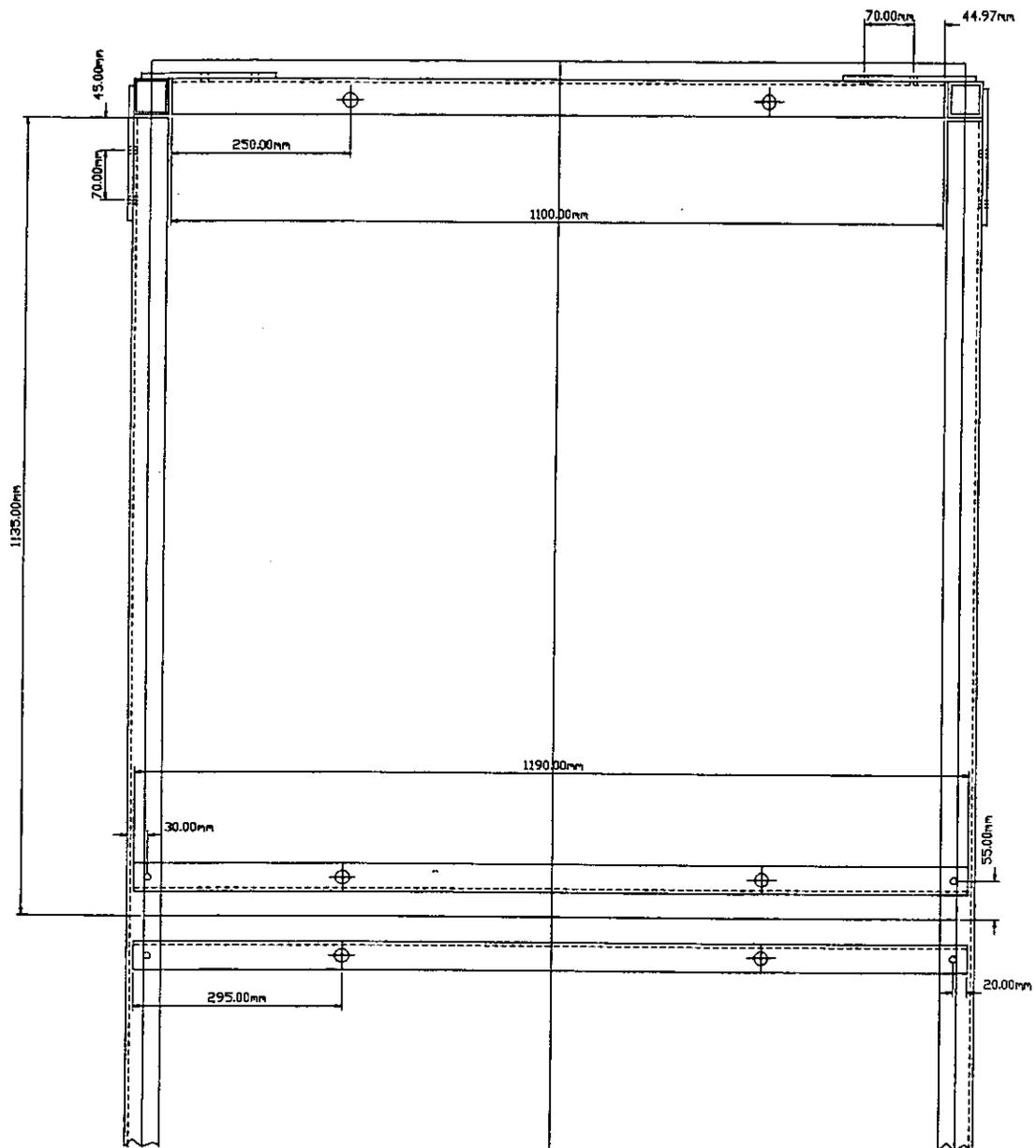


Fig. 5 Rudder and propeller test definition.



<i>SPECIFICATIONS</i>	CONTRACT NO. C60 R47	COMPANY University of Southampton Department of Ship Science	
	Information Only	TITLE Rudder and Propeller Zero J Test Rig	
FDR: Workshop	DESIGNED BY: Jason Smithwick	End View of Assembly	
	All dimensions in mm. Do not scale from drawing.	SIZE A4	DWG NO. / FILE NAME END.SKD
		SCALE 1mm = 10mm	DATE 26/10/95
			SHEET 1 of 1

Fig. 6 Rudder and propeller zero J test rig: - End View of Assembly



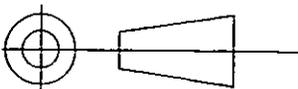
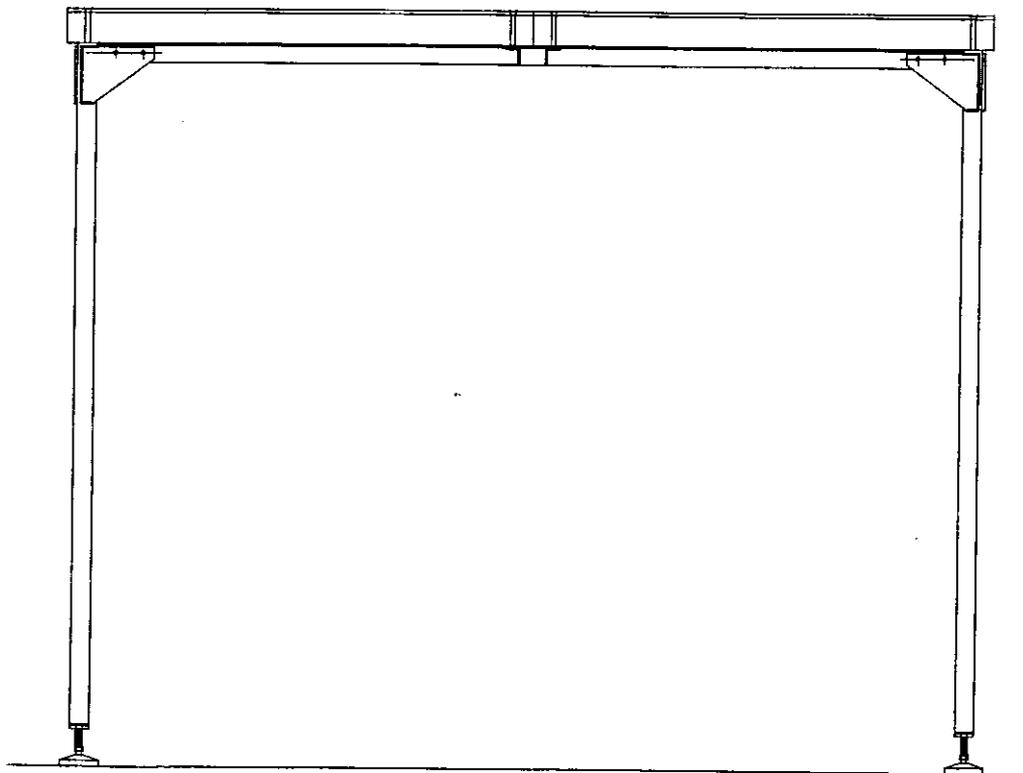
<i>SPECIFICATIONS</i>	CONTRACT NO. C60 R47	COMPANY University of Southampton Department of Ship Science		
Information Only	DRAWN BY: Jason Smithwick Room 1015, Building 22 Extension 3584	TITLE Rudder and Propeller Zero J Test Rig Plan View of Assembly		
FDR: Workshop	DESIGNED BY: Jason Smithwick	SIZE A4	FSCM NO.	DWG NO. / FILE NAME PLAN.SKD
	All dimensions in mm. Do not scale from drawing.	SCALE 1mm = 10mm	DATE 25/10/95	SHEET 1 of 1

Fig. 7 Rudder and propeller zero J test rig:- Plan View of Assembly



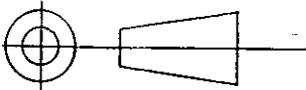
<i>SPECIFICATIONS</i>	CONTRACT NO. C60 R47	COMPANY University of Southampton Department of Ship Science		
	Information Only	DRAWN BY: Jason Smithwick Room 1015, Building 22 Extension 3584	TITLE Rudder and Propeller Zero J Test Rig Profile Assembly Drawing	
FDR: Workshop	DESIGNED BY: Jason Smithwick	SIZE A4	FSCM NO.	DWG NO. / FILE NAME PROFILE.SKD
	All dimensions in mm. Do not scale from drawing.	SCALE 1mm = 20mm	DATE 26/10/95	SHEET 1 of 1

Fig. 8 Rudder and propeller zero J test rig:- Profile View of Assembly



Title, description and location of rig RUDDER-PROPELLER INTERACTION RIG.

A RIG USED TO MEASURE FORCES ON A RUDDER MOUNTED IN WAY
OF A 0.8M DIAMETER PROPELLER WHICH CAN RUN UP TO 3,000 RPM.

Nature of hazard/risk

THE MAIN HAZARD IS ASSOCIATED WITH ROTATING MACHINERY, DRIVE BELTS
TAKE POWER FROM A 30KW ELECTRIC MOTOR TO A FOUR BLADED PROPELLER.
THIS PROPELLER ROTATES AT UP TO 3,000 RPM. THE RIG IS TO BE USED
IN THE GEORGE EDWARDS LABORATORY.

Control measures and safety precautions required (ventilation, personal protection)

THE PROPELLER, RUDDER AND DATA ACQUISITION IS REMOTELY OPERATED.
ACCESS, WHILE OPERATING, IS RESTRICTED TO OPERATORS WHILE IN GEORGE
EDWARDS LABORATORY.

Rig operating procedures

THE ELECTRIC MOTOR IS REMOTELY OPERATED BY A
CONTROL BOX WITH EMERGENCY STOP BUTTON. THE RUDDER IS REMOTELY OPERATED
BY A COMPUTER AND ELECTRIC TURNABLE TO ALTER INCIDENCE. EAR DEFENDERS
SHOULD BE USED AT PROPELLER SPEEDS ABOVE 2,200 RPM.

Named authorised operators

DR. S.R. TURNOCK.

DR. A.F. MOLLAND.

MR. J.E.T. SMITHUCK.

MR. N.C. RYCROFT.

Supervisor's signature [Signature] Date 8/1/96

Safety Officer's approval [Signature] Date 8/1/96

Head of Department's signature

Recorded File Number

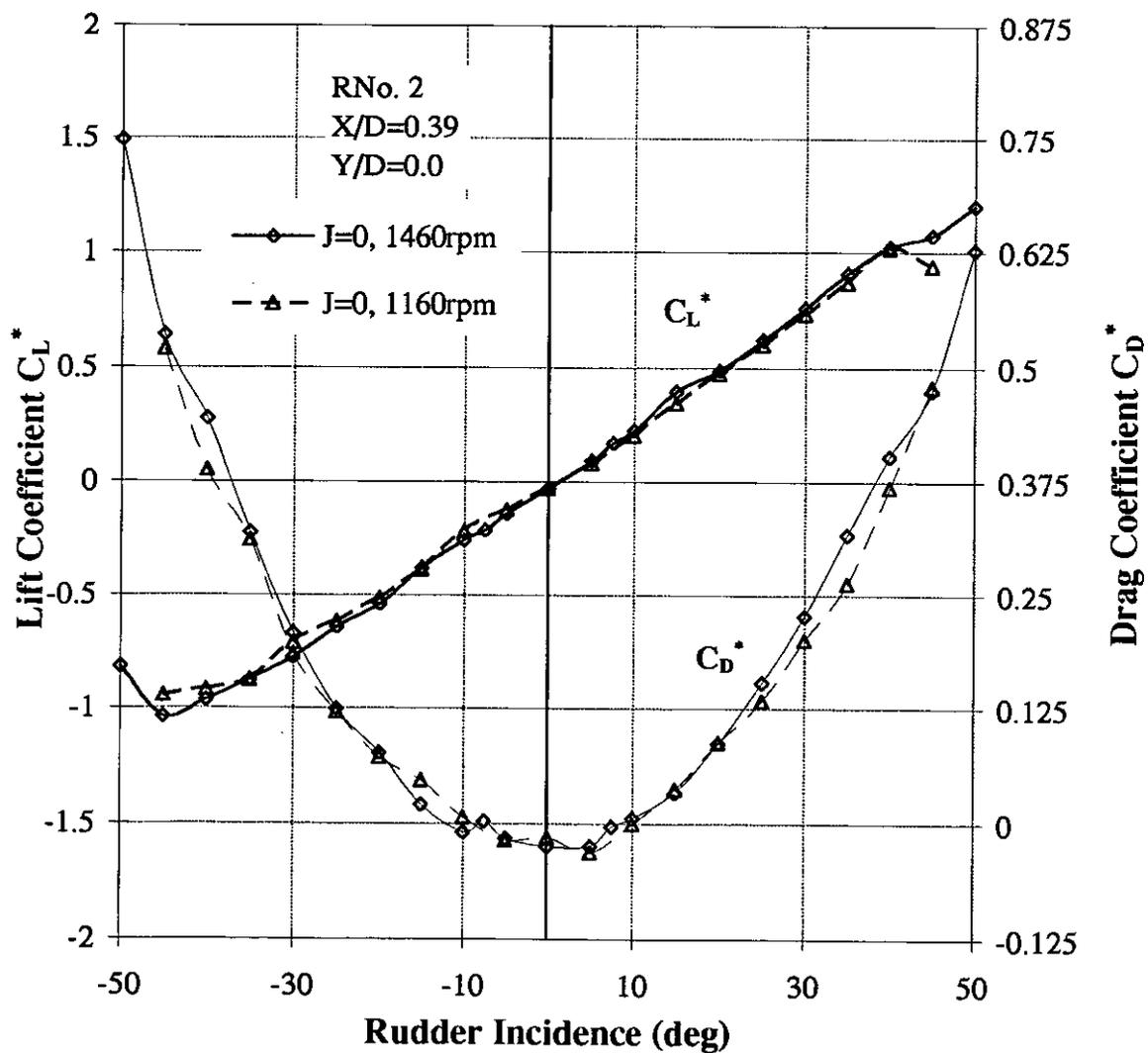
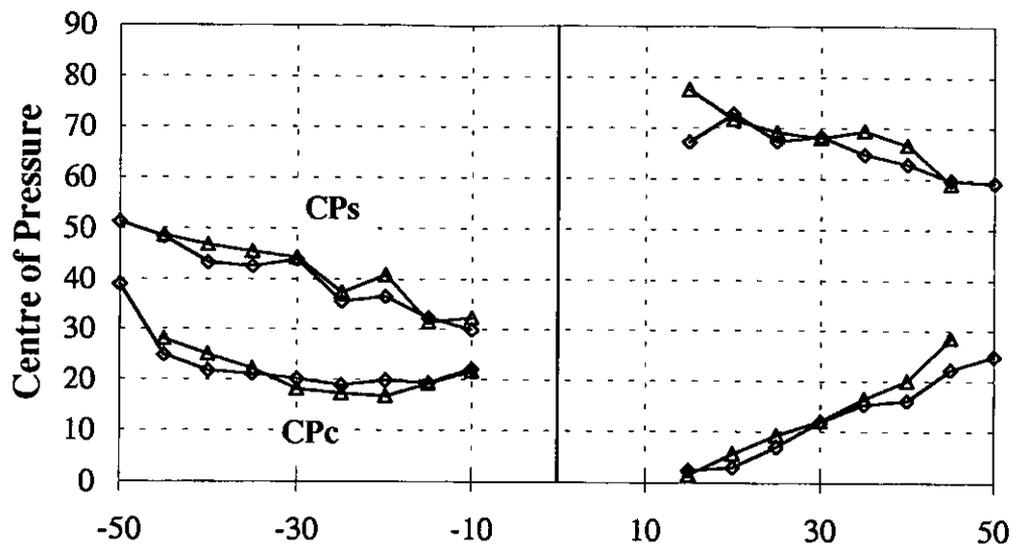


Fig. 10 Influence of Propeller RPM at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2

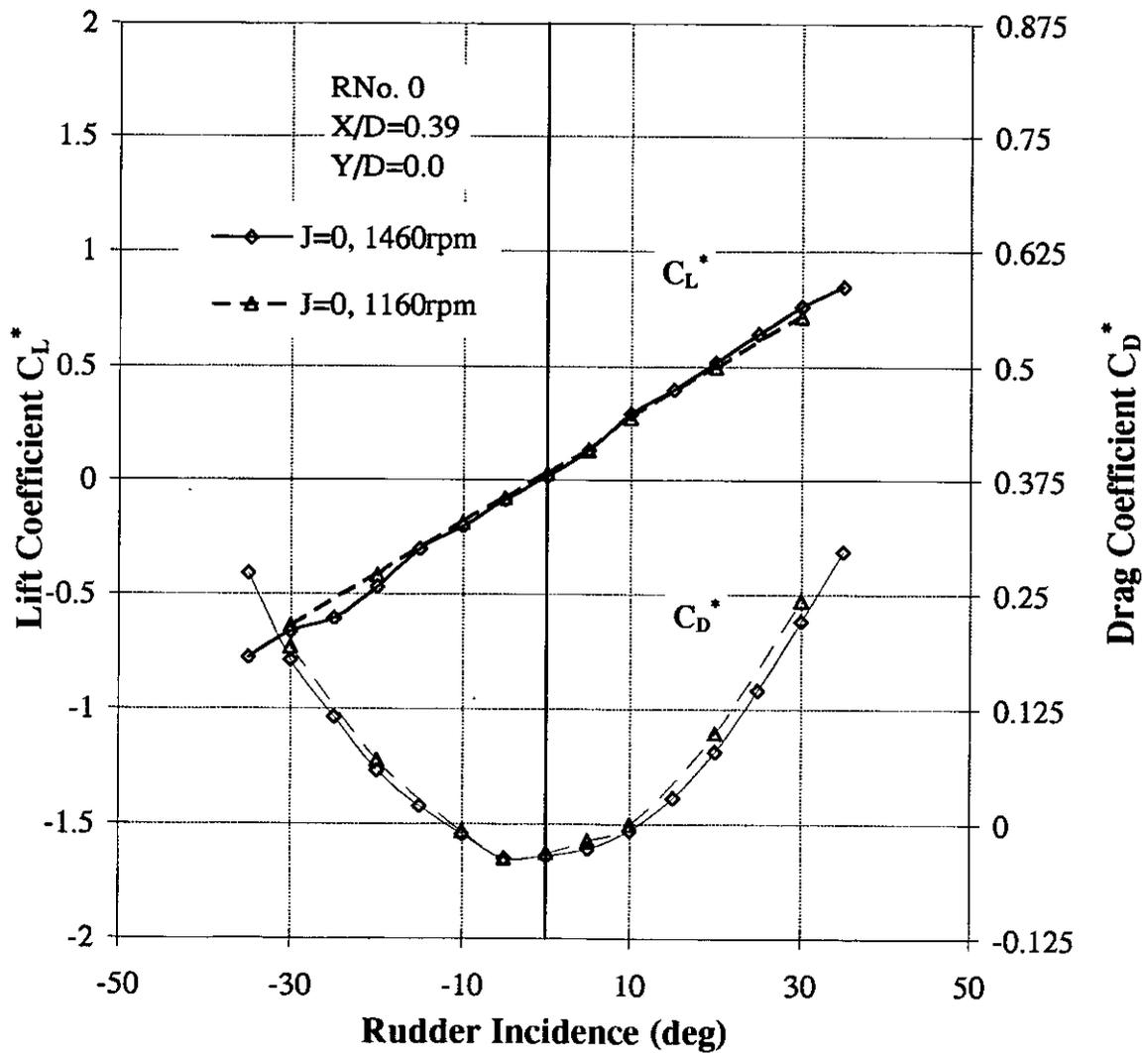
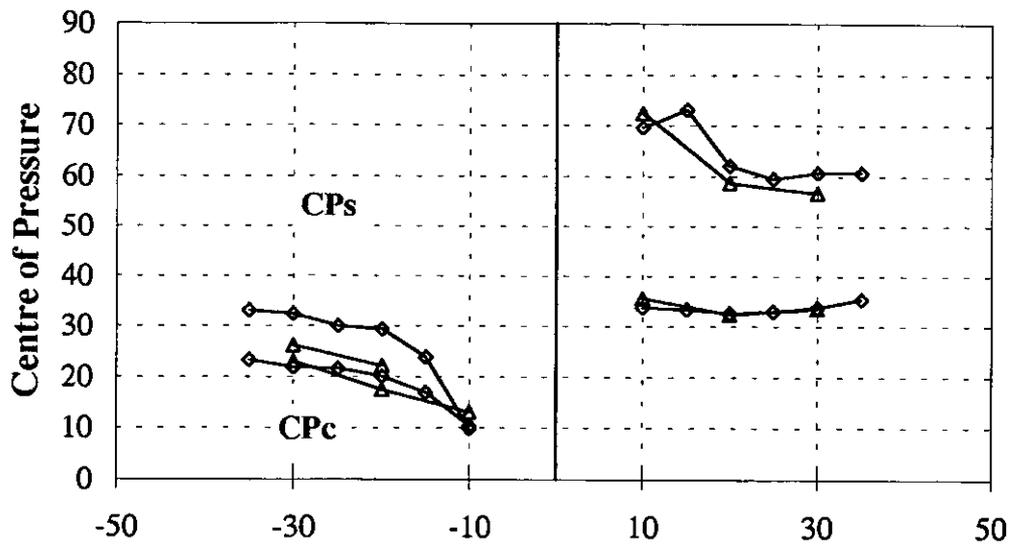


Fig. 11 Influence of Propeller RPM at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0

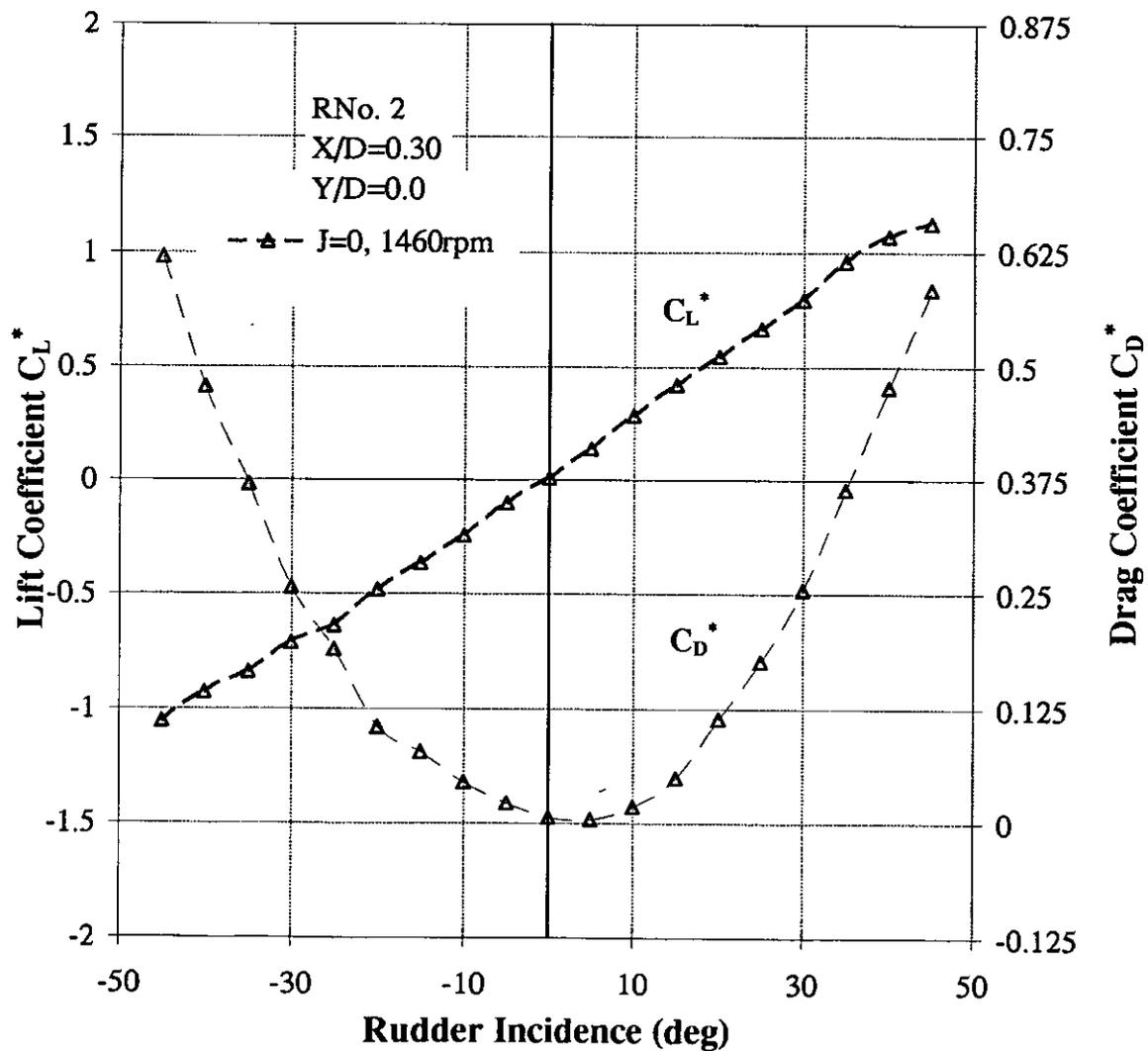
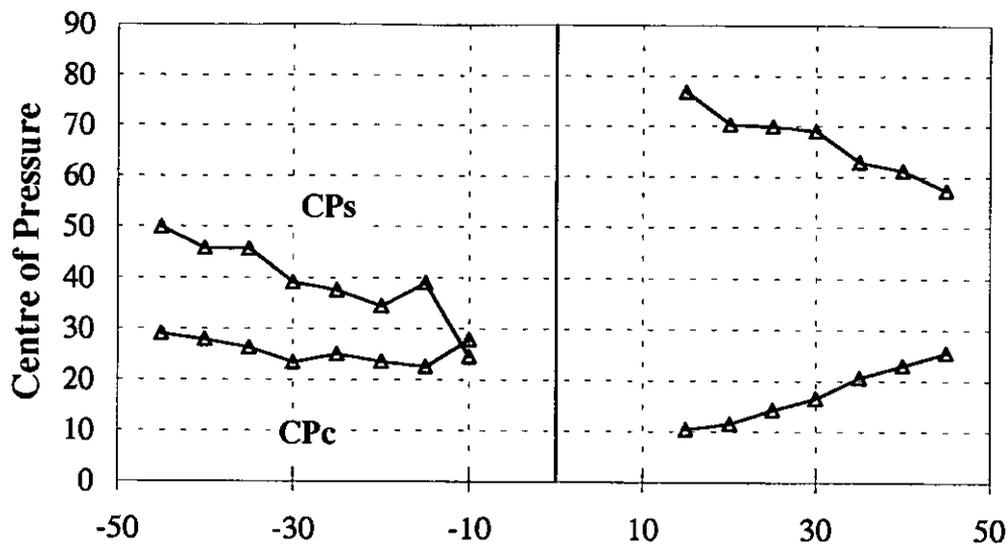


Fig. 12 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Longitudinal Separation of $X/D=0.30$.

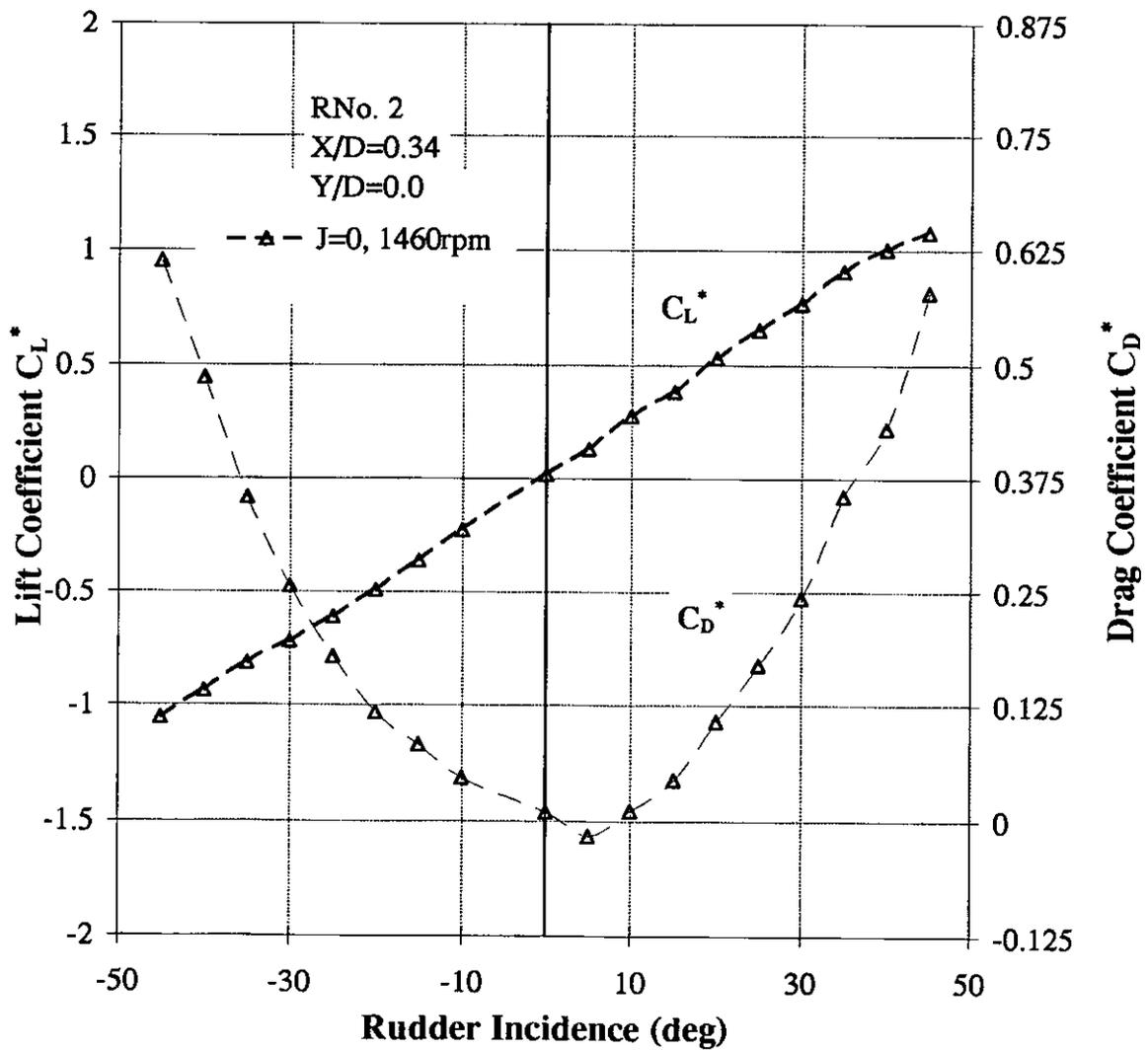
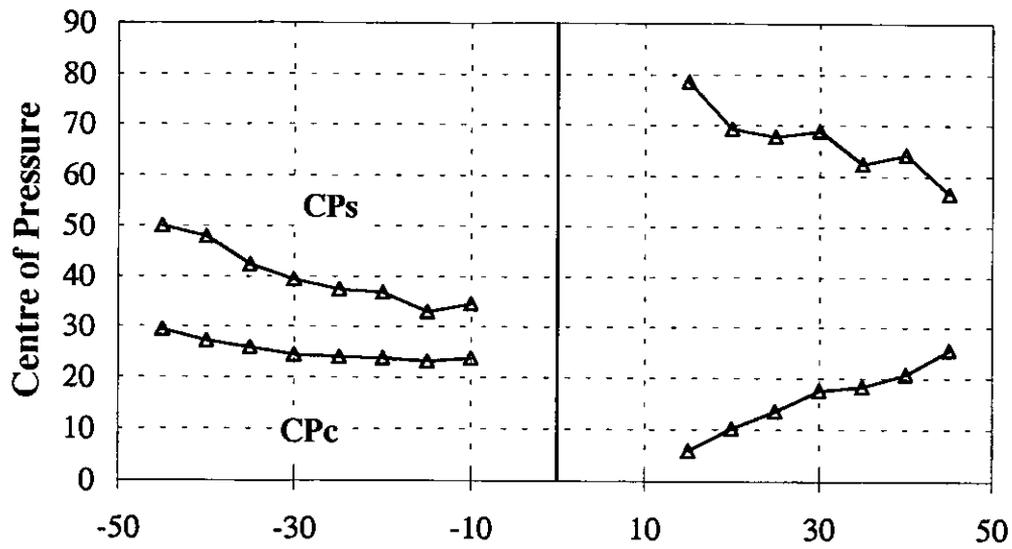


Fig. 13 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Longitudinal Separation of $X/D=0.34$.

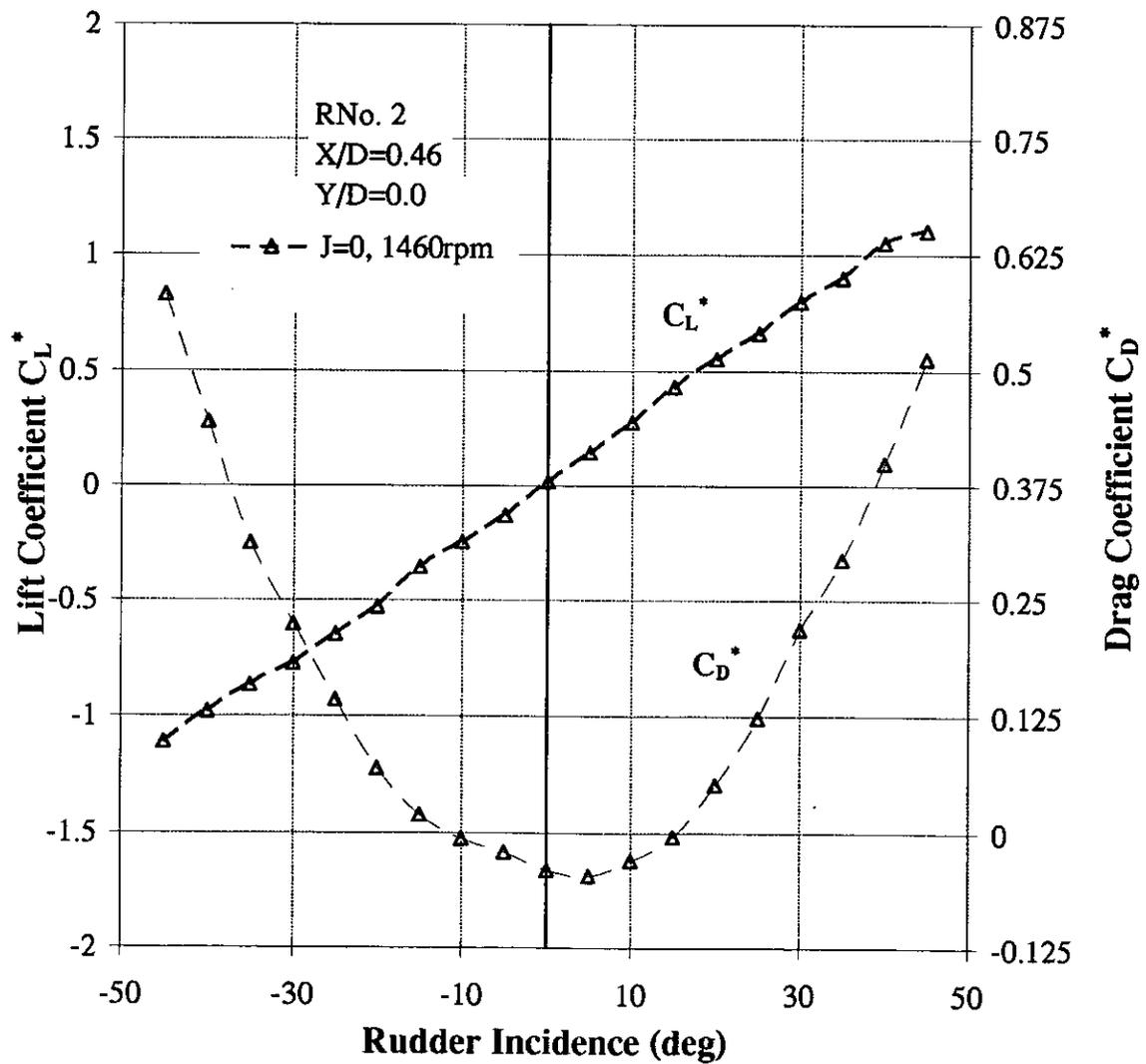
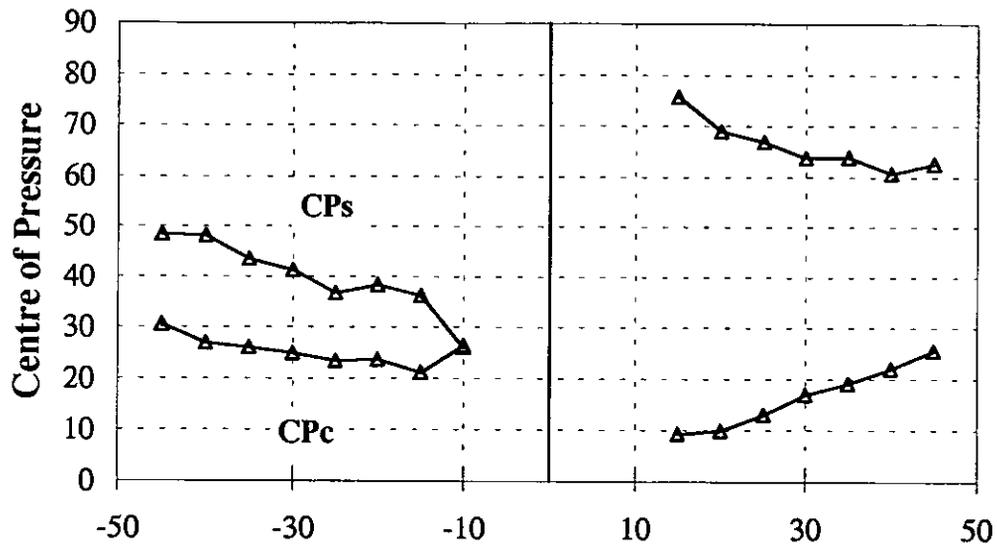


Fig. 14 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Longitudinal Separation of $X/D=0.46$.

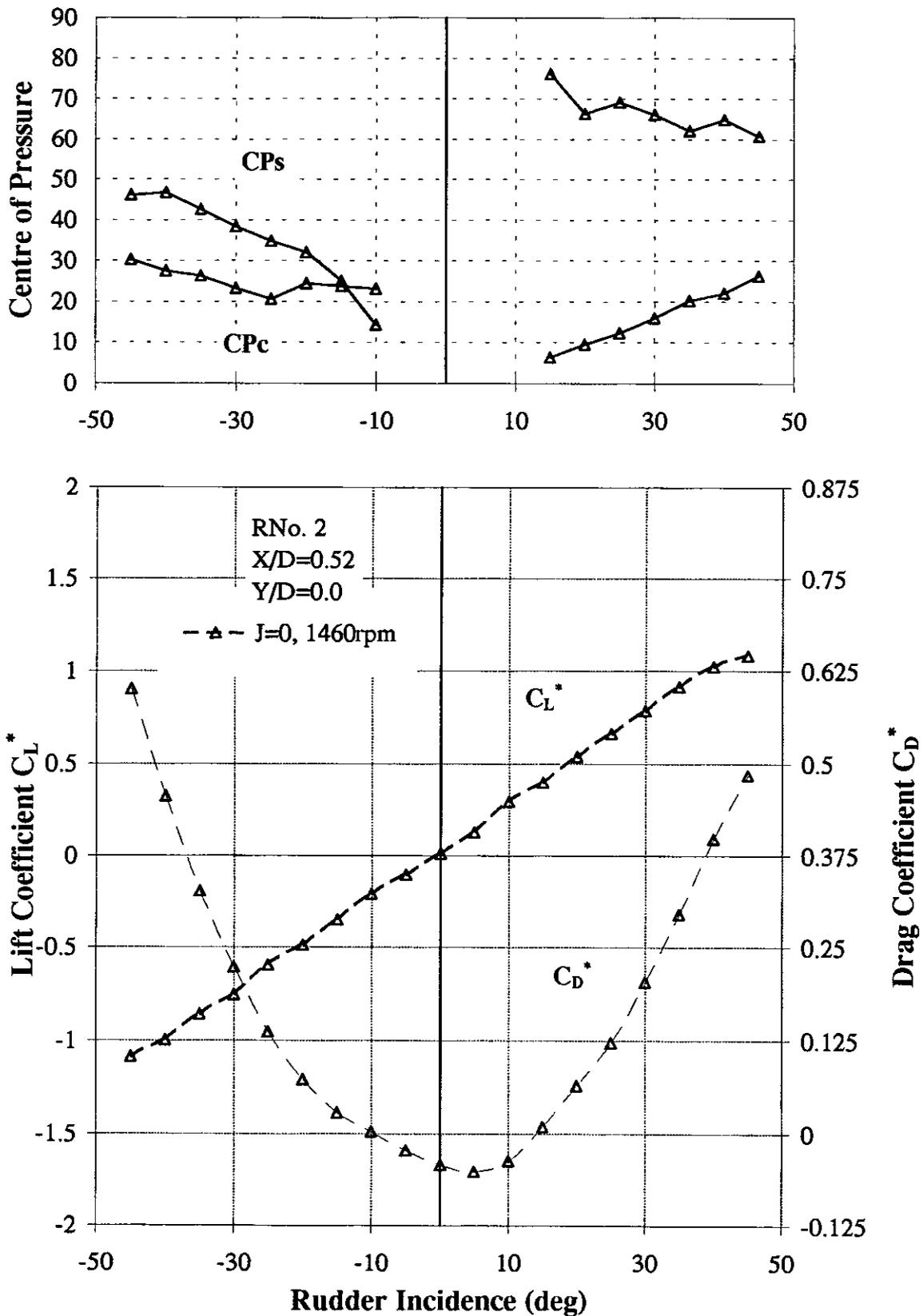


Fig. 15 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Longitudinal Separation of $X/D=0.52$.

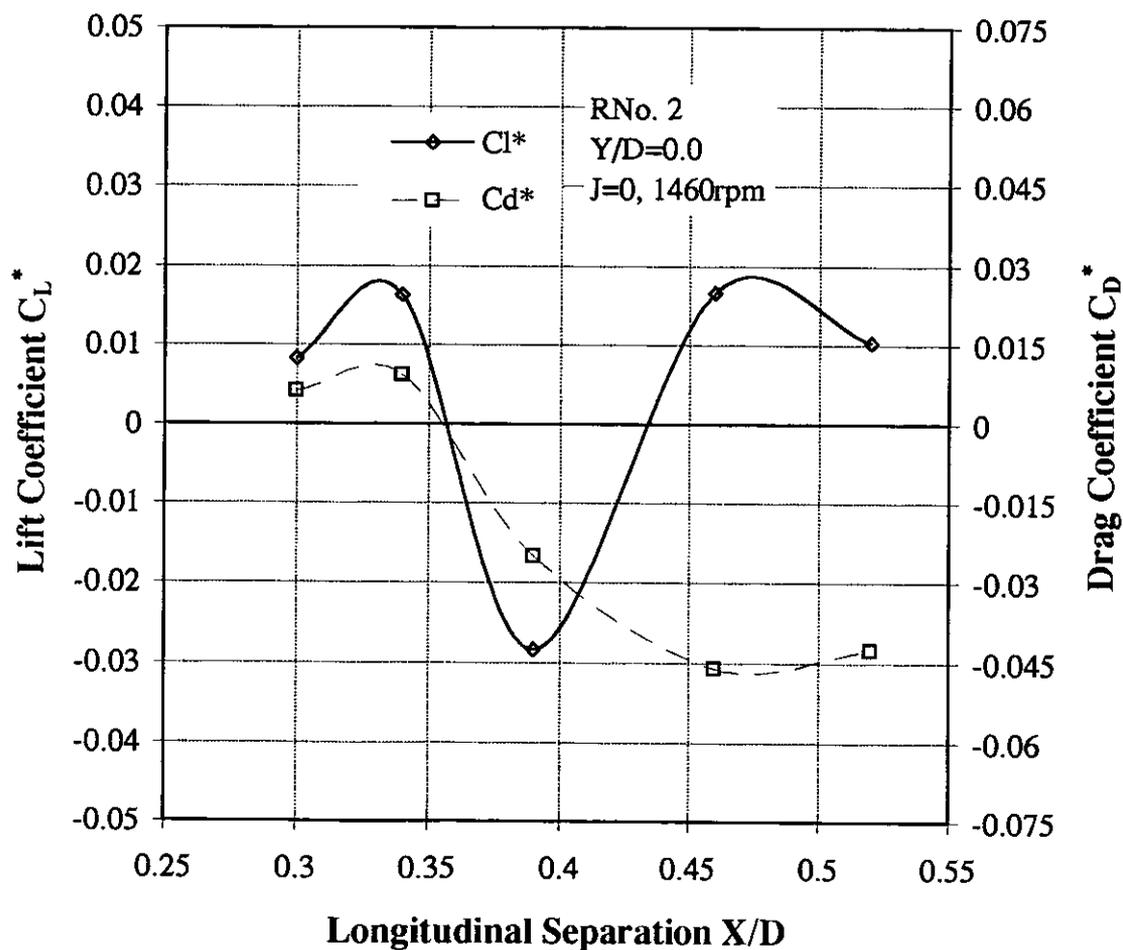


Fig. 16 Influence of Longitudinal Separation (X/D) on Lift and Drag at Zero Incidence of All-Movable Rudder No. 2 at Zero Advance Ratio (J=0)

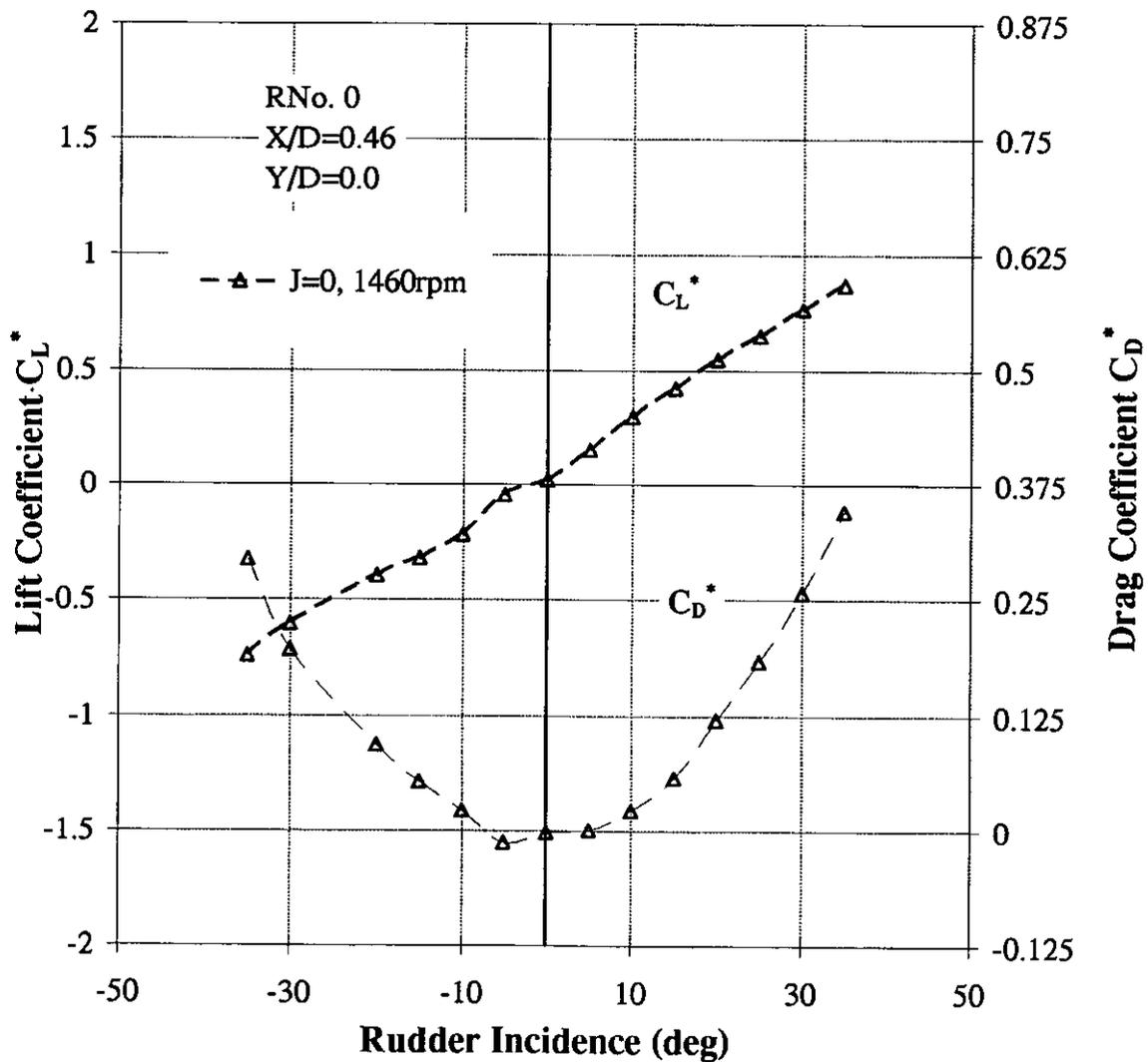
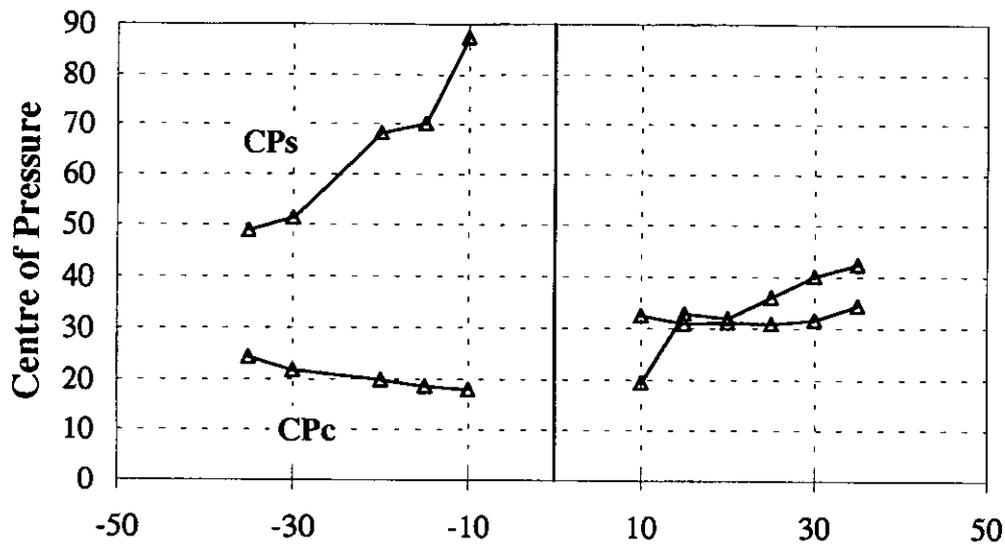


Fig. 17 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Longitudinal Separation of $X/D=0.46$.

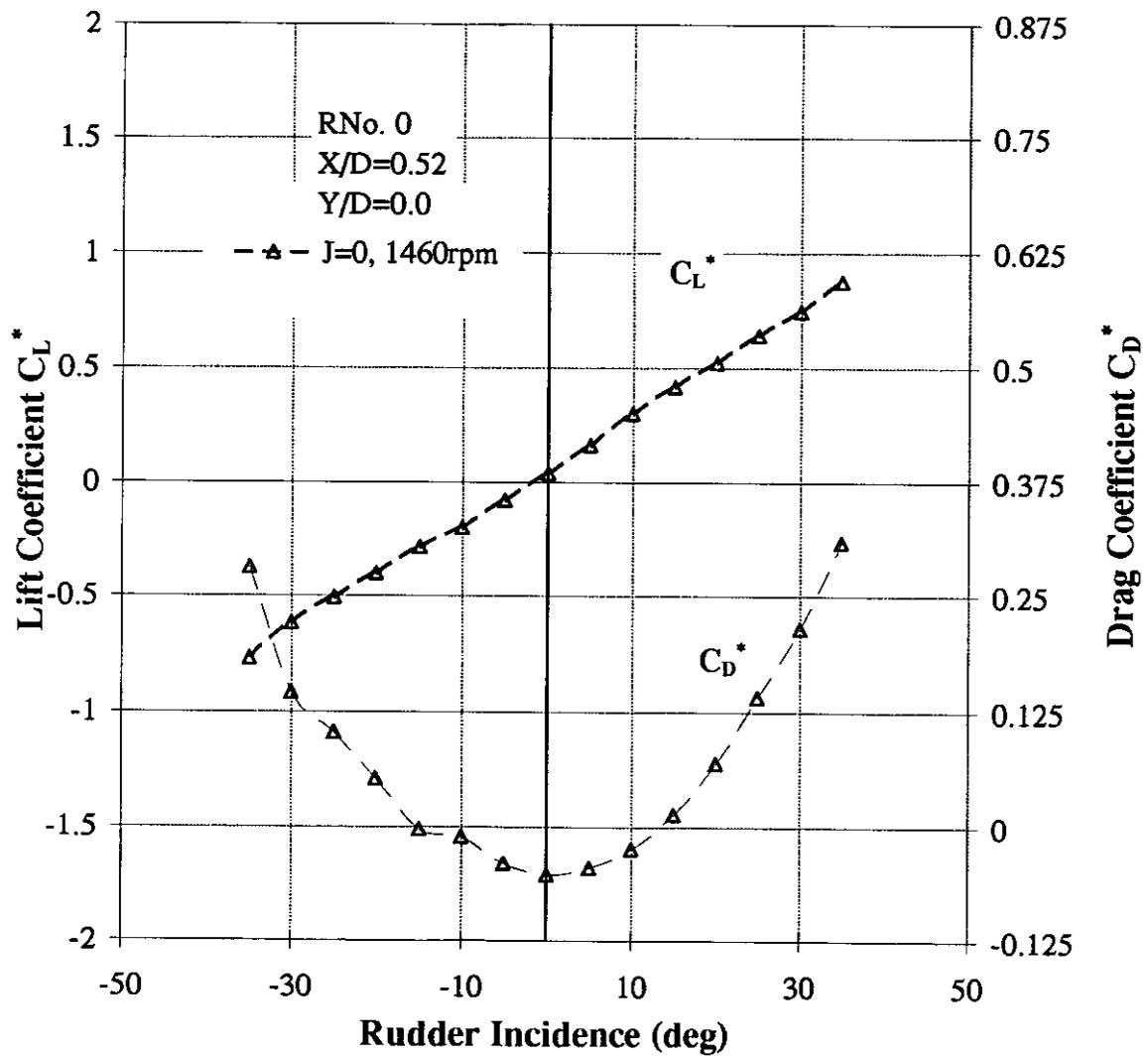
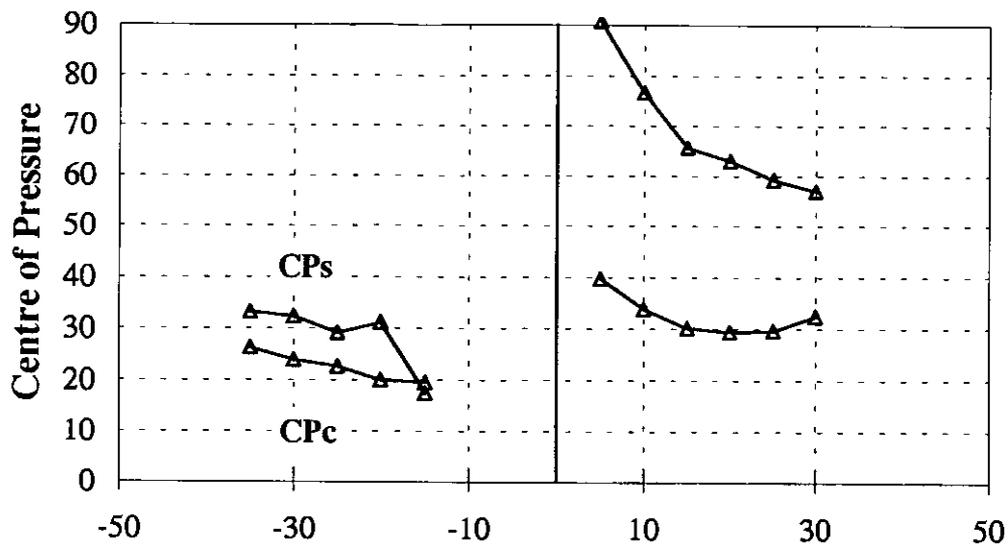


Fig. 18 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Longitudinal Separation of $X/D=0.52$.

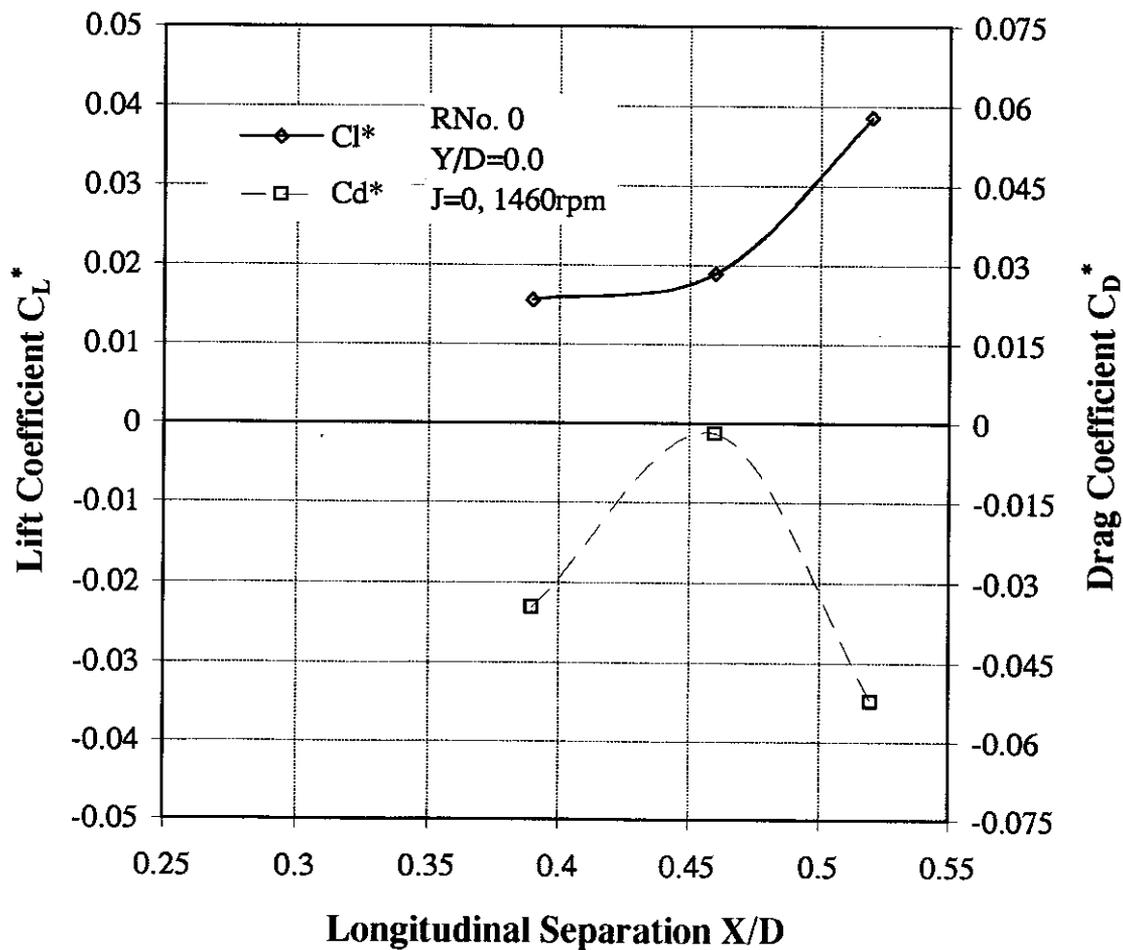


Fig. 19 Influence of Longitudinal Separation (X/D) on Lift and Drag at Zero Incidence of Skeg-Rudder No. 0 at Zero Advance Ratio (J=0)

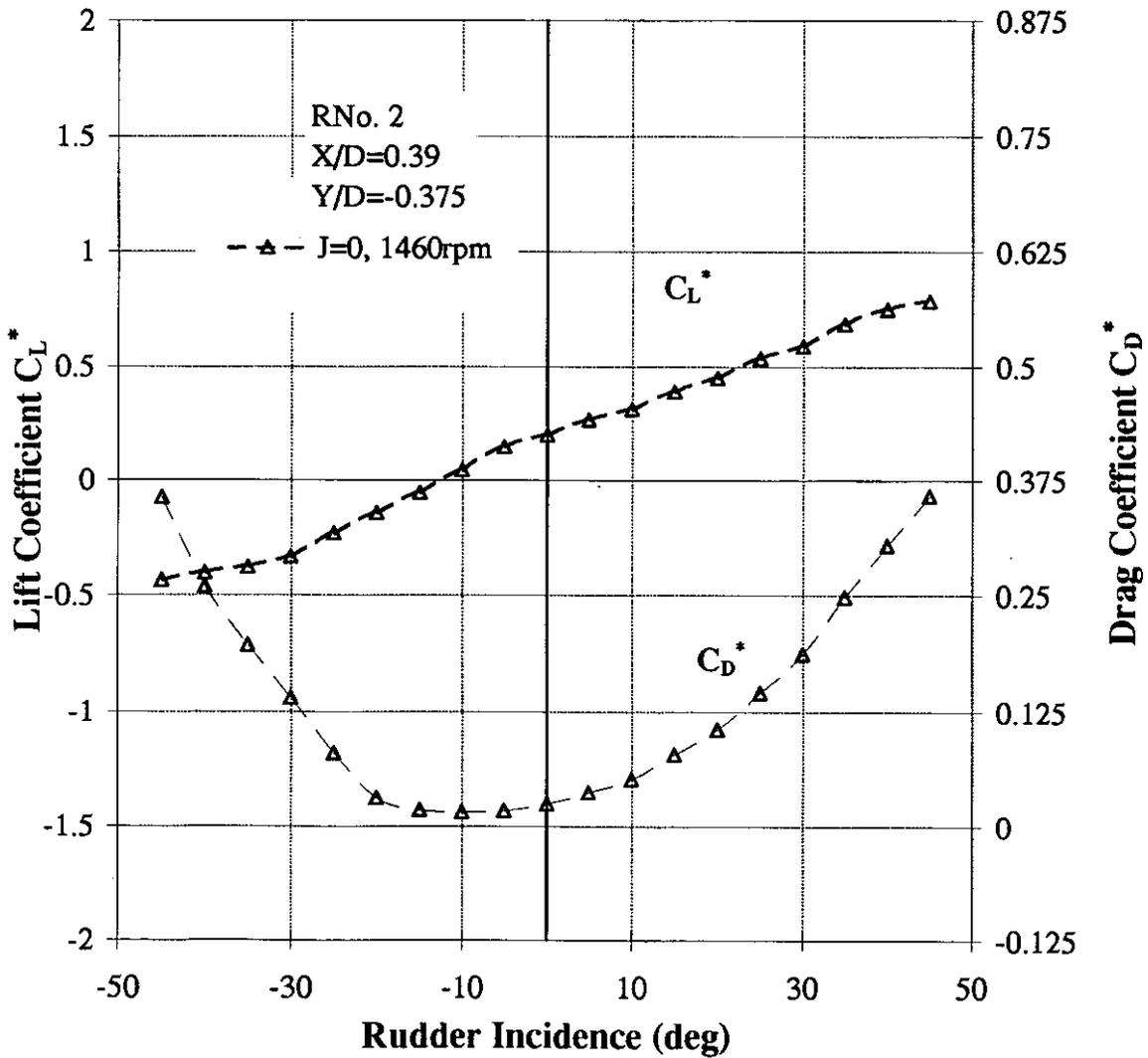
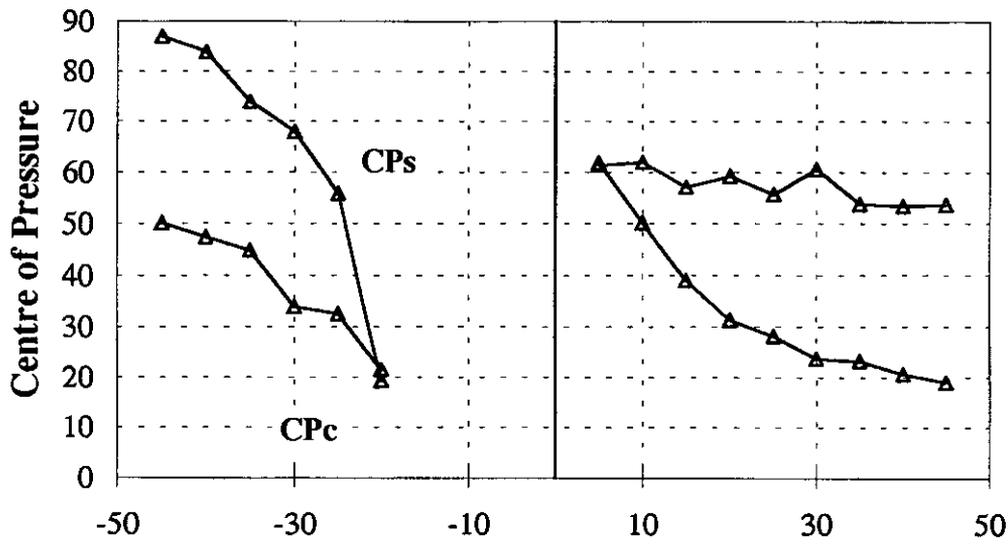


Fig. 20 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=-0.375$

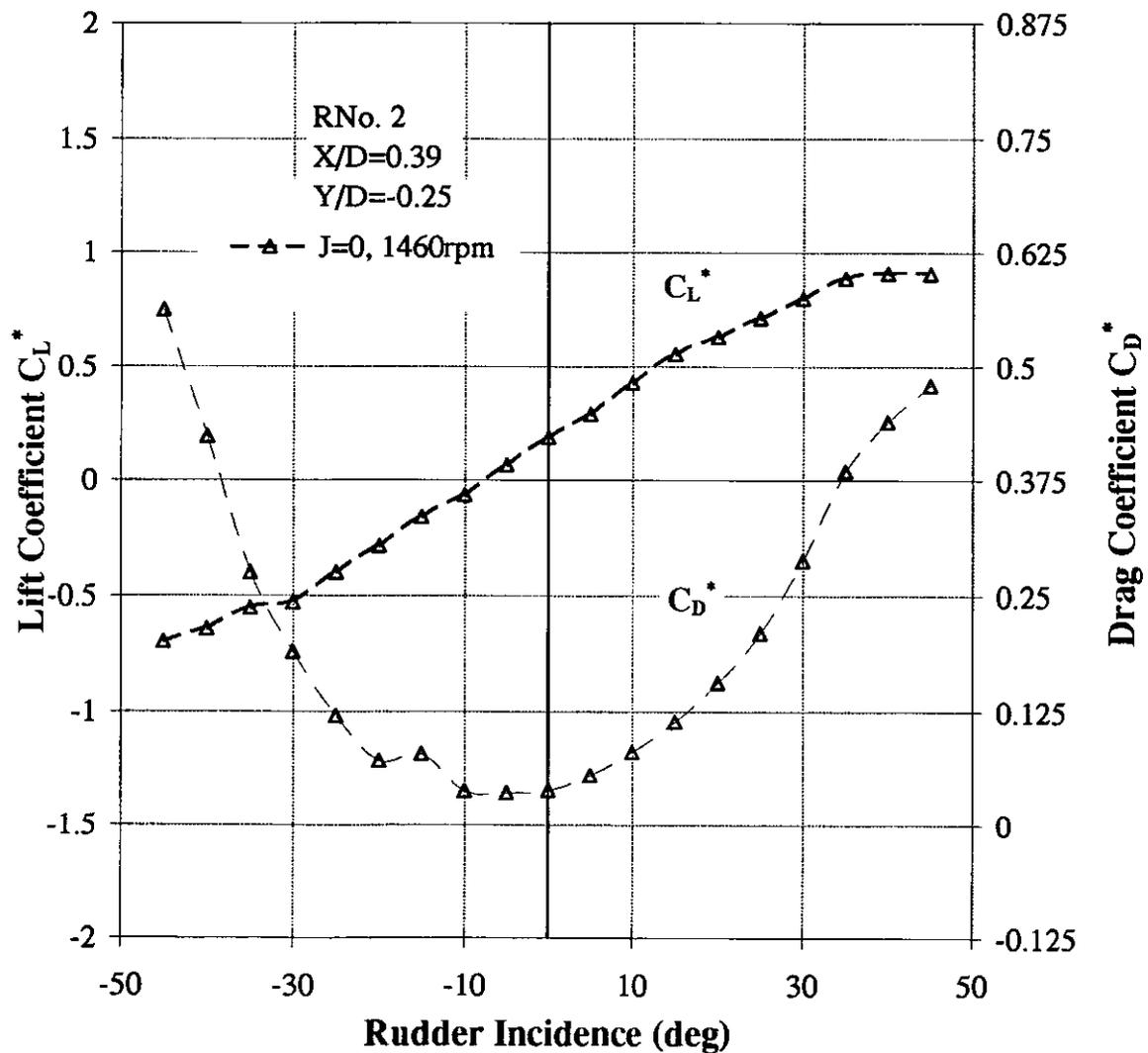
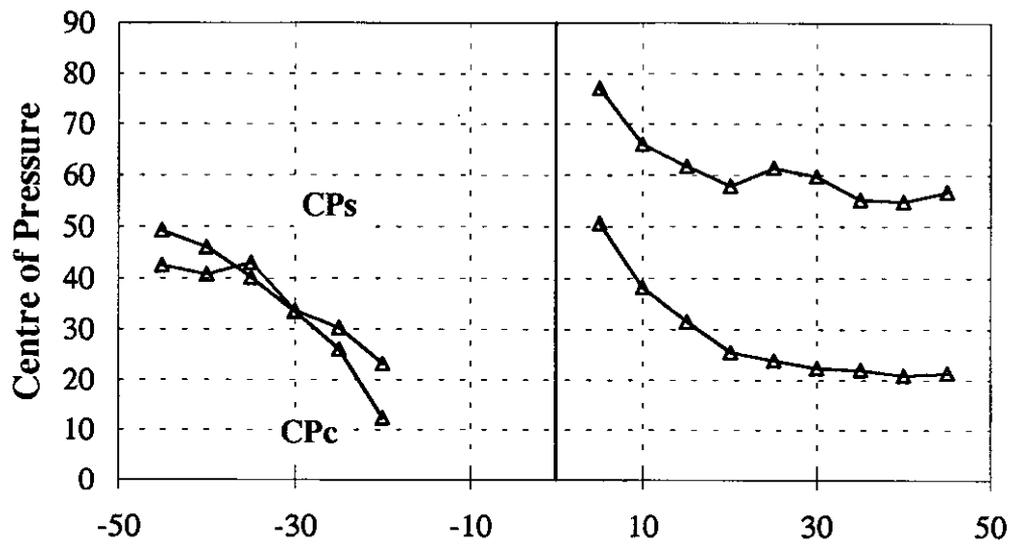


Fig. 21 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=-0.25$

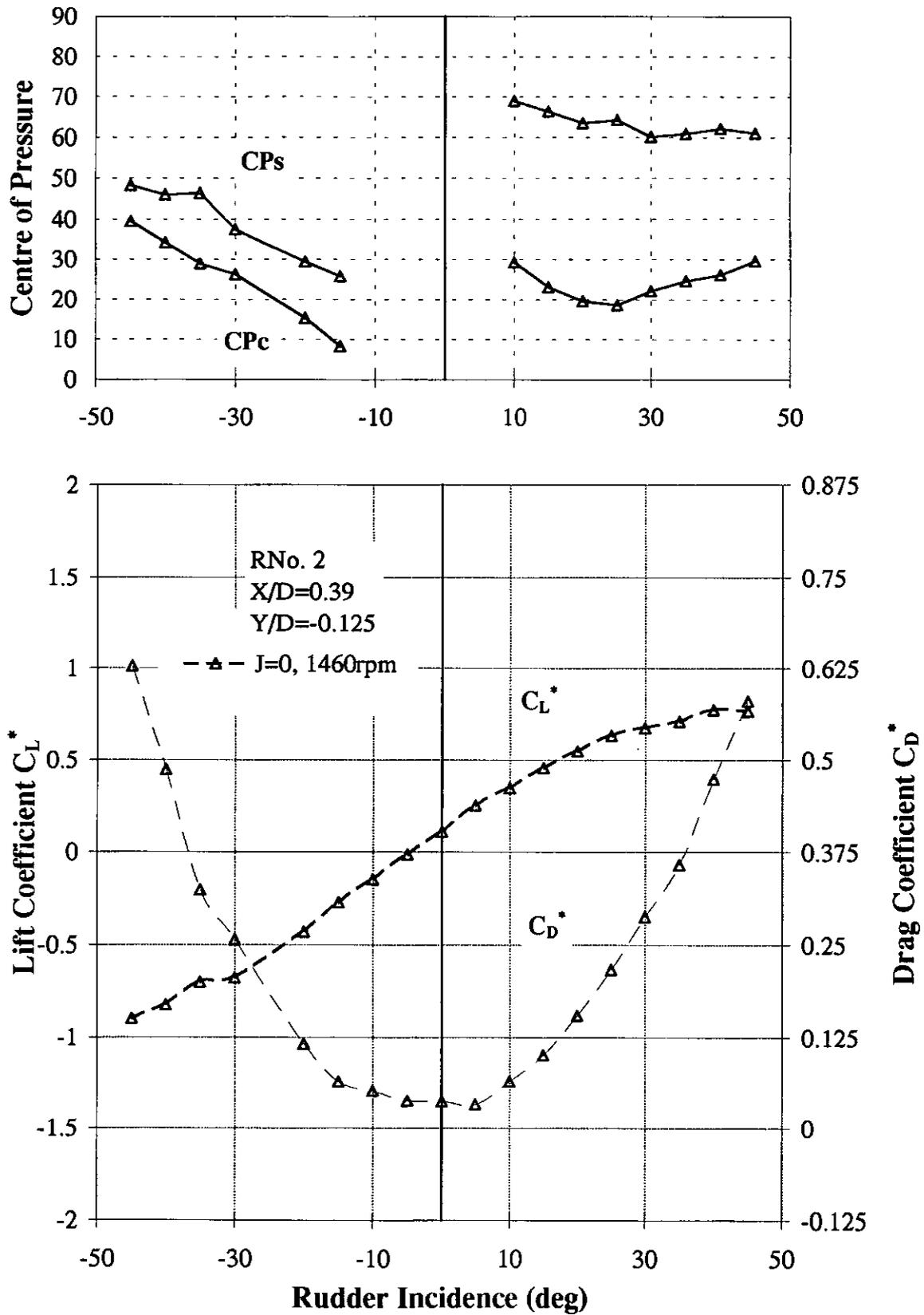


Fig. 22 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=-0.125$

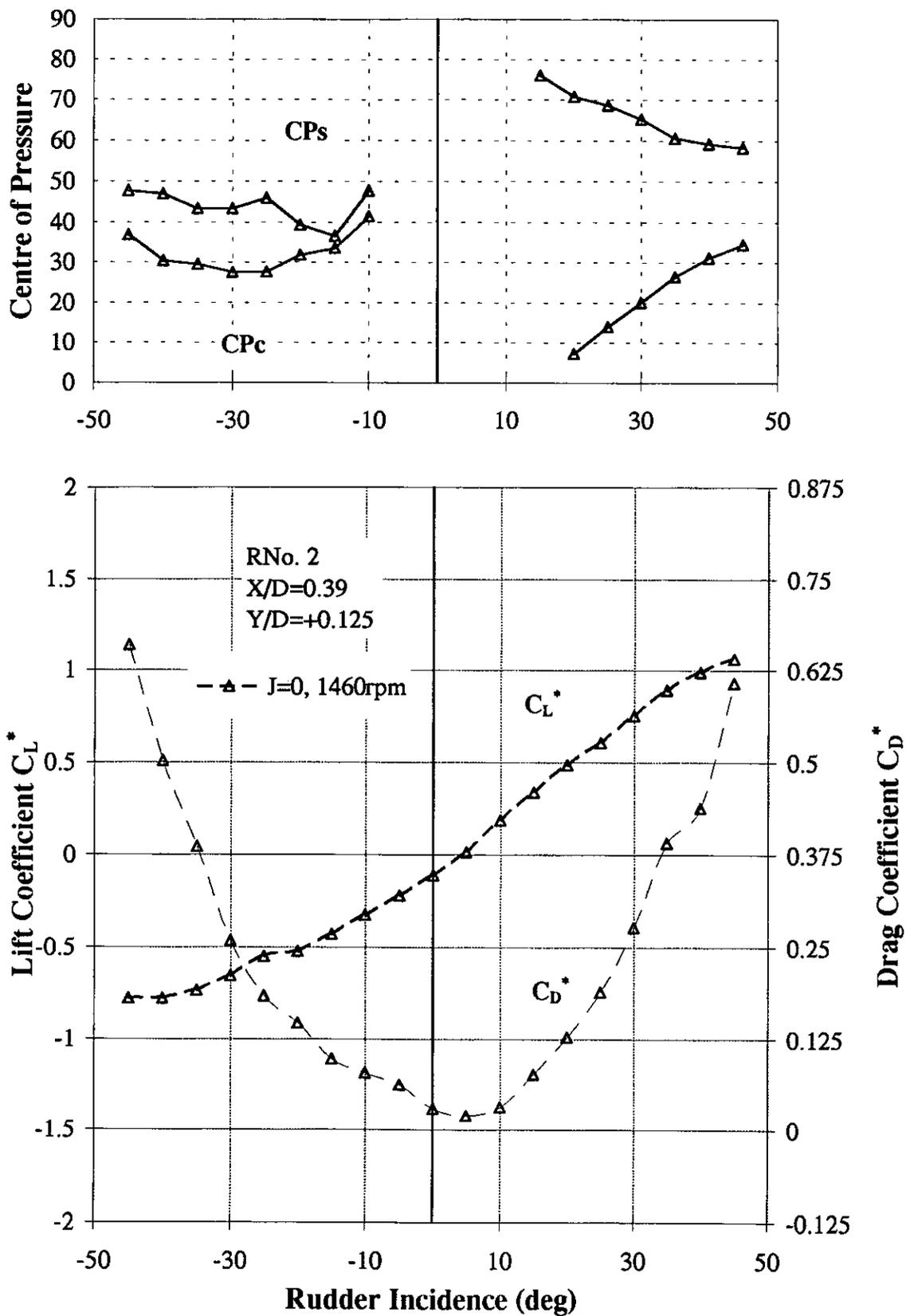


Fig. 23 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=+0.125$

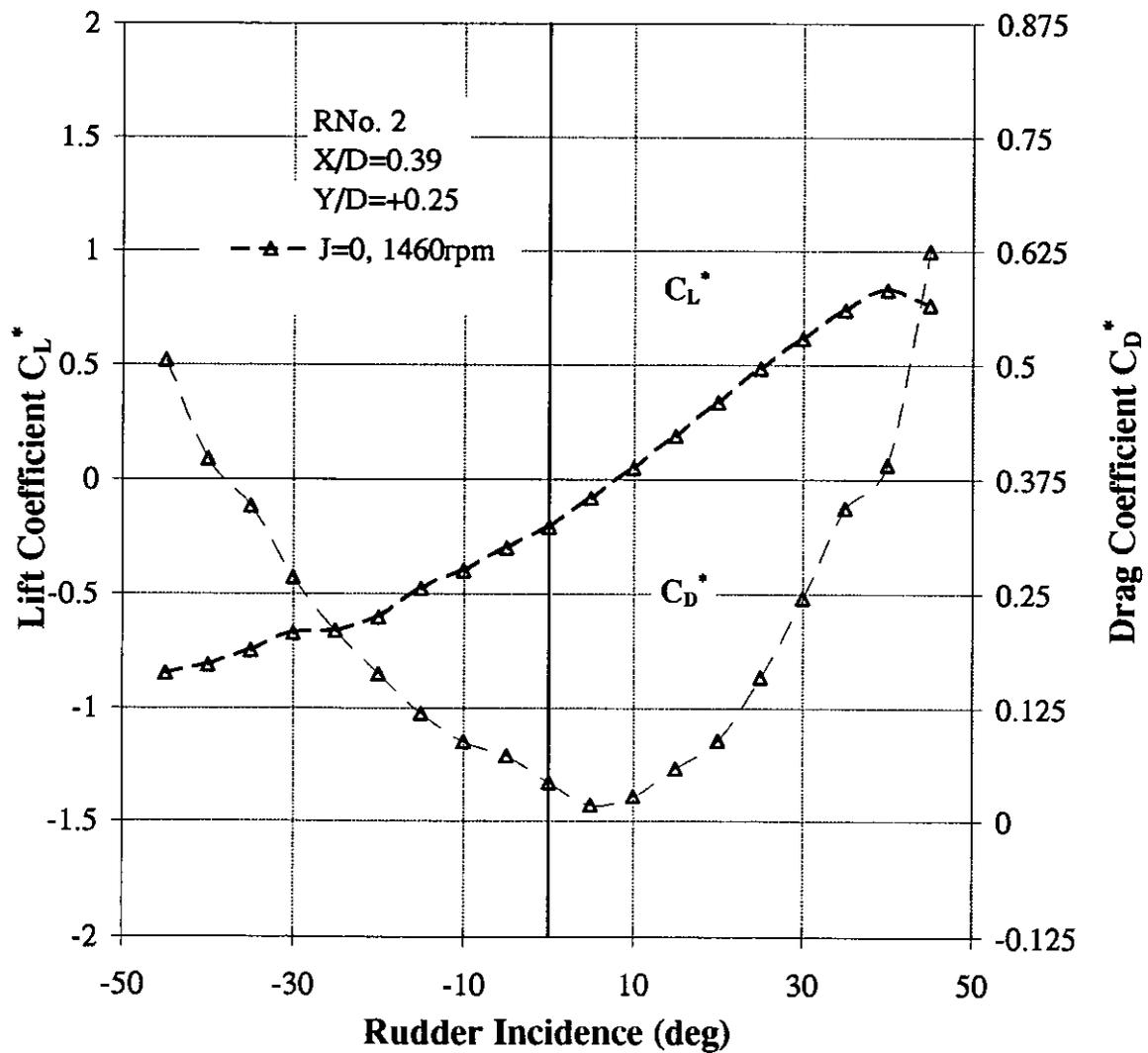
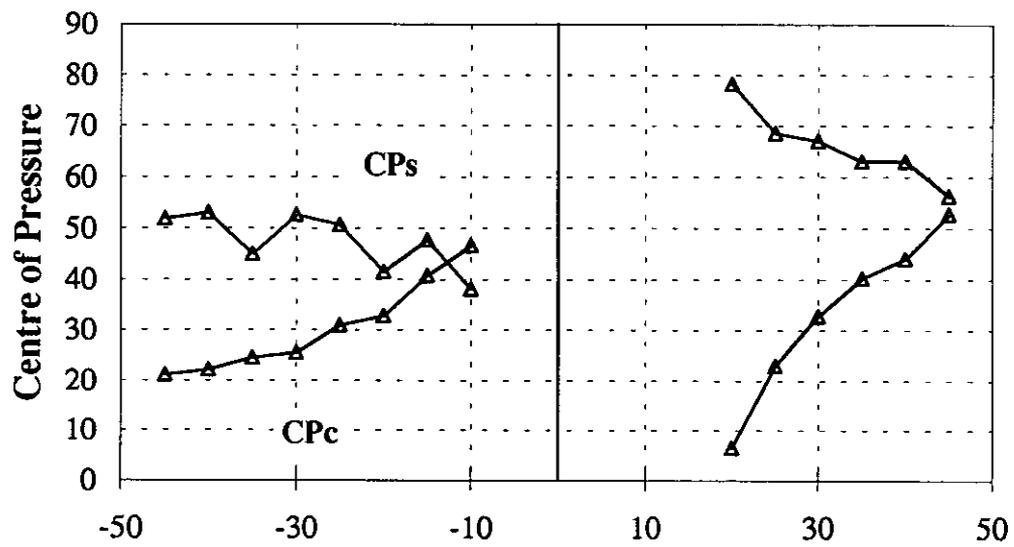


Fig. 24 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=+0.25$

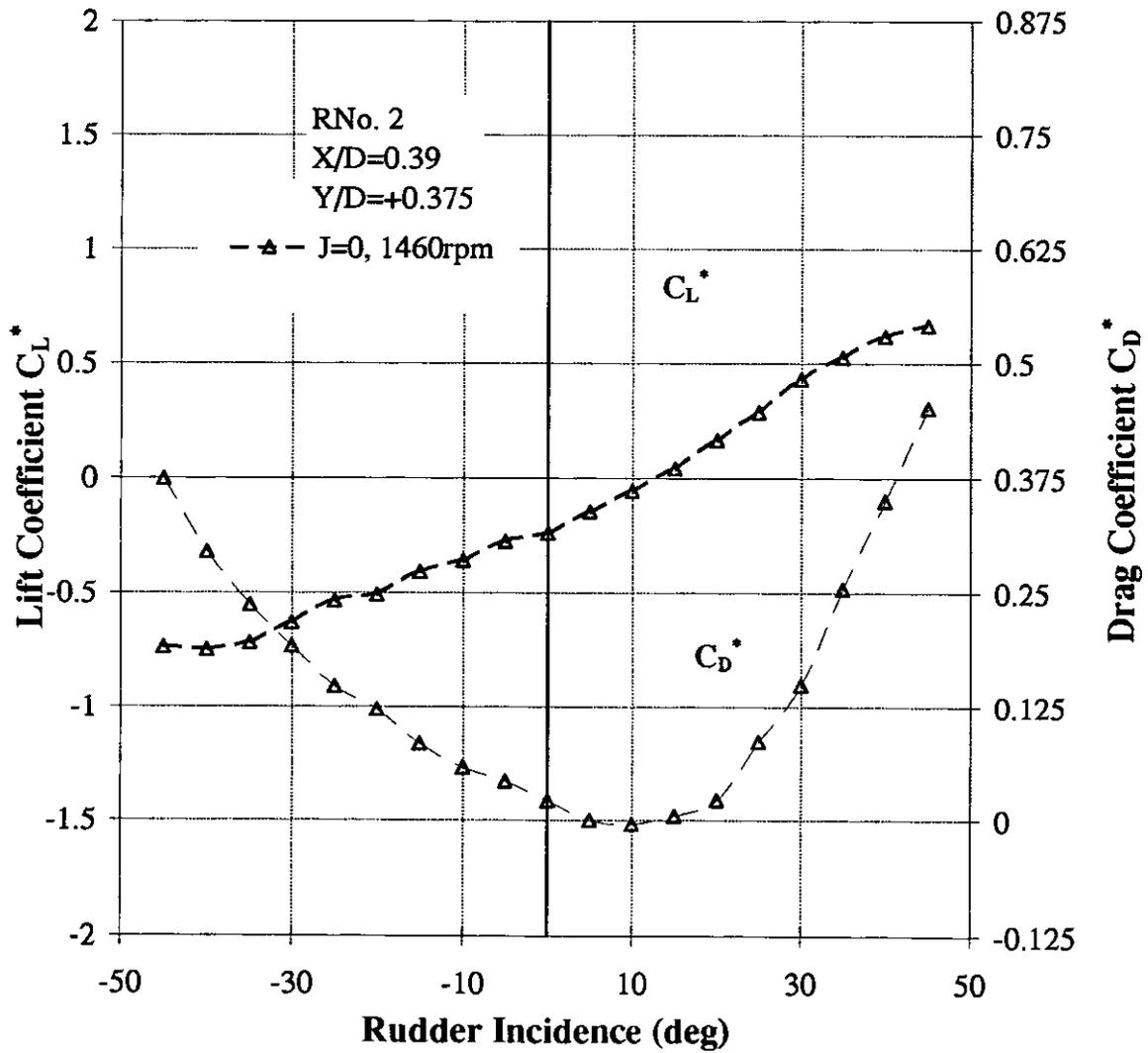
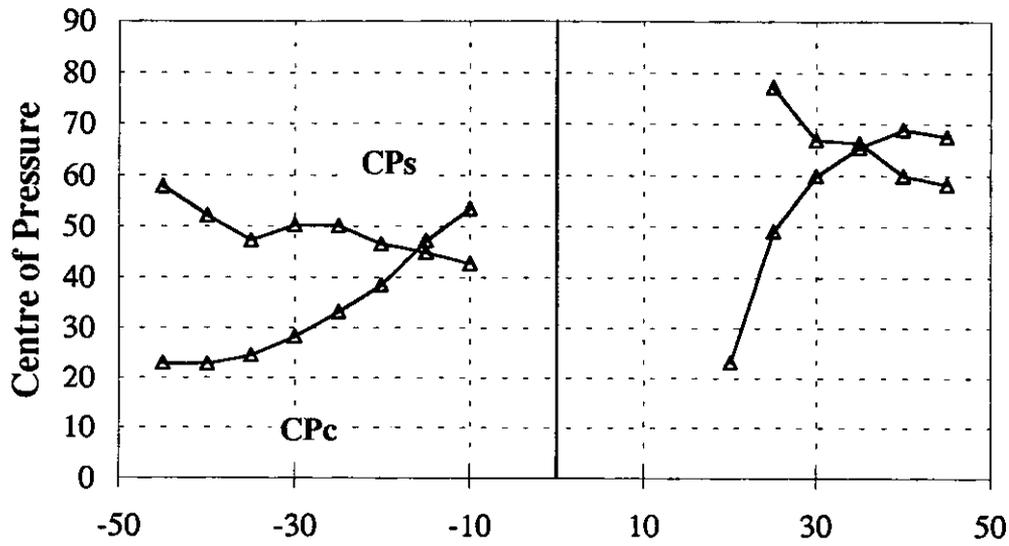


Fig. 25 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=+0.375$

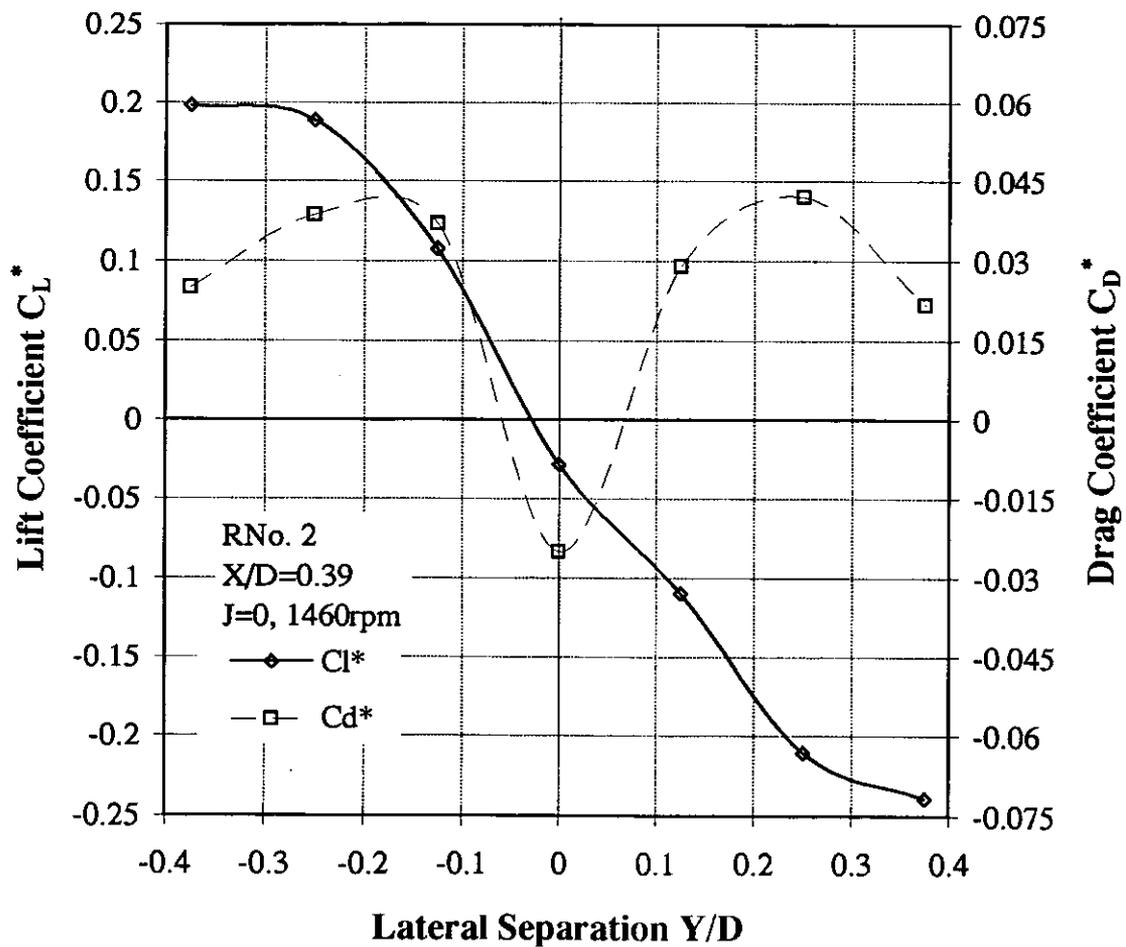


Fig. 26 Influence of Lateral Separation (Y/D) on Lift and Drag at Zero Incidence of All-Movable Rudder No. 2 at Zero Advance Ratio (J=0)

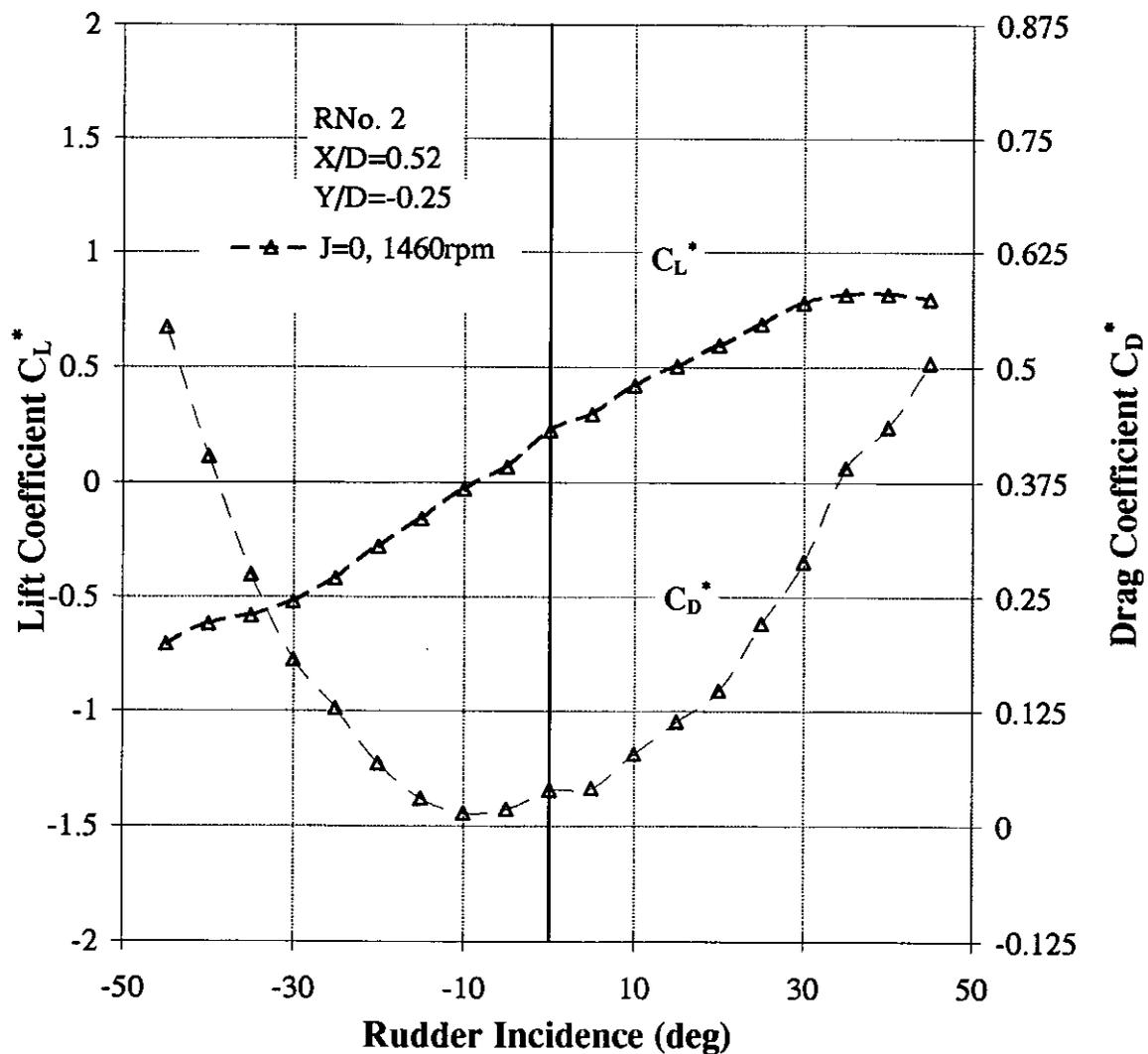
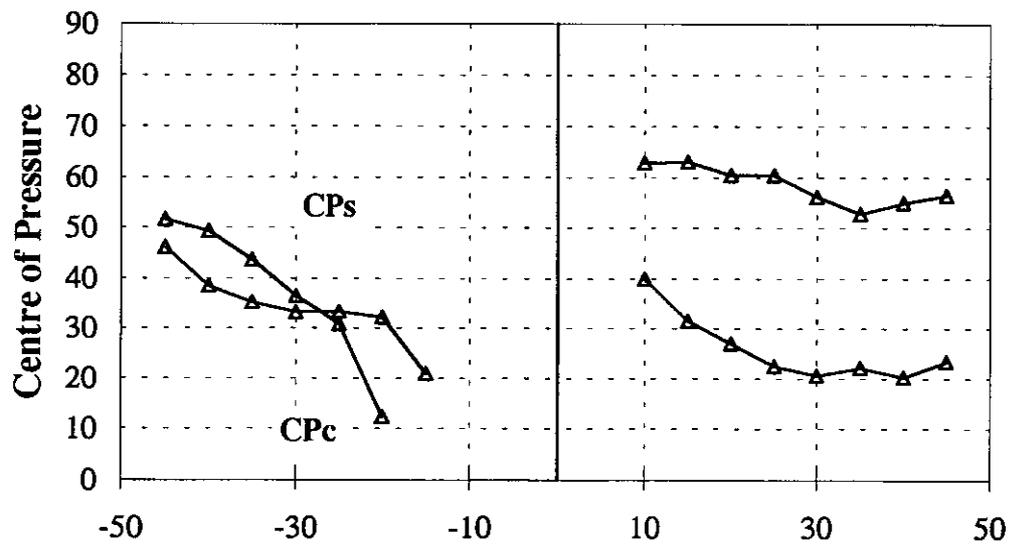


Fig. 27 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=-0.25$ and a Longitudinal Separation of $X/D=0.52$.

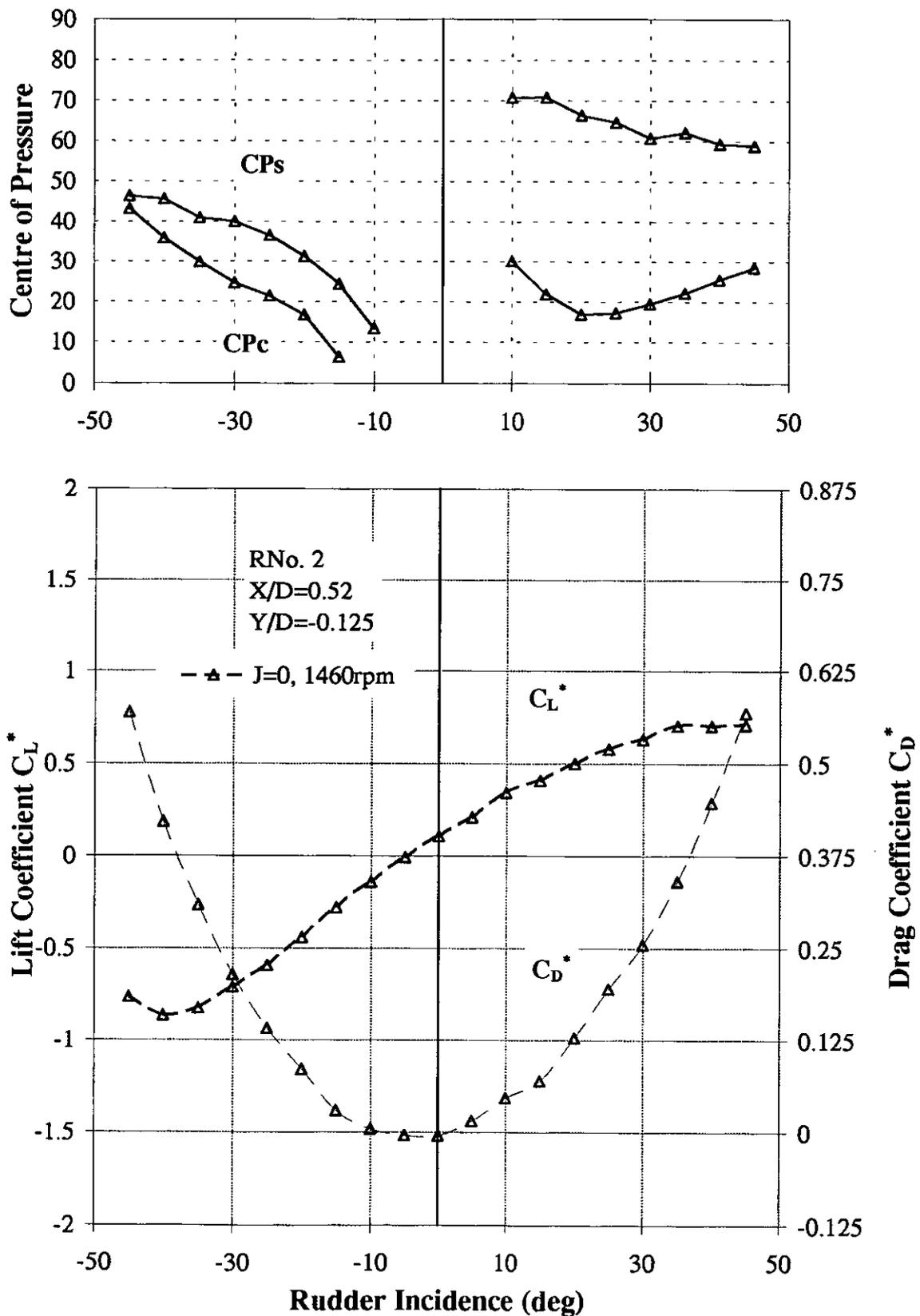


Fig. 28 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=-0.125$ and a Longitudinal Separation of $X/D=0.52$.

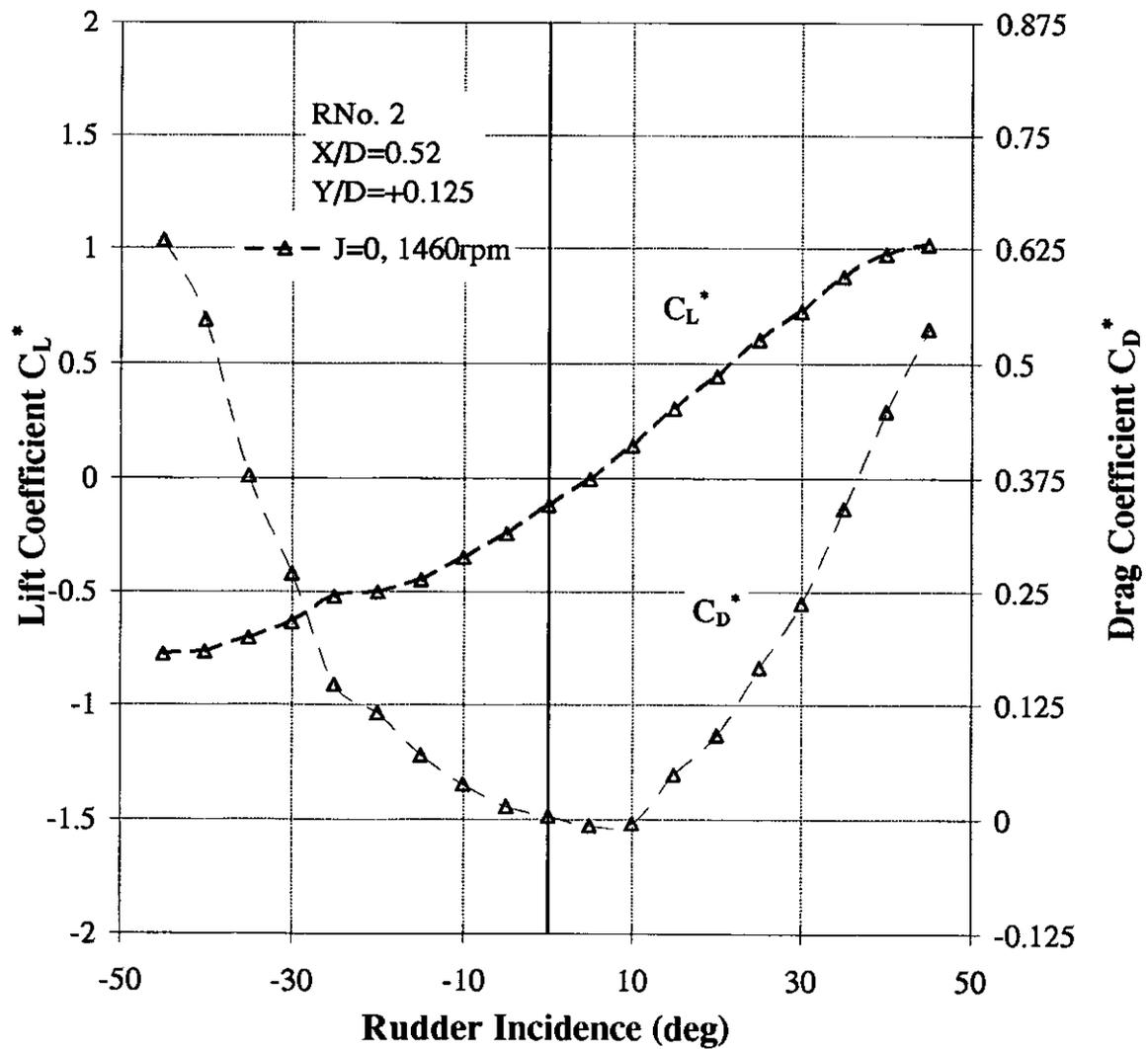
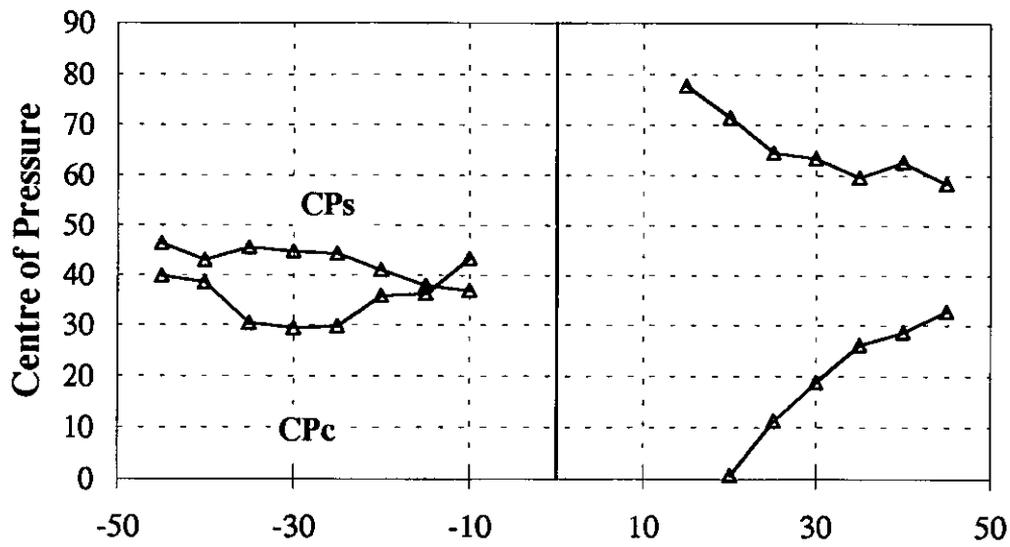


Fig. 29 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=+0.125$ and a Longitudinal Separation of $X/D=0.52$.

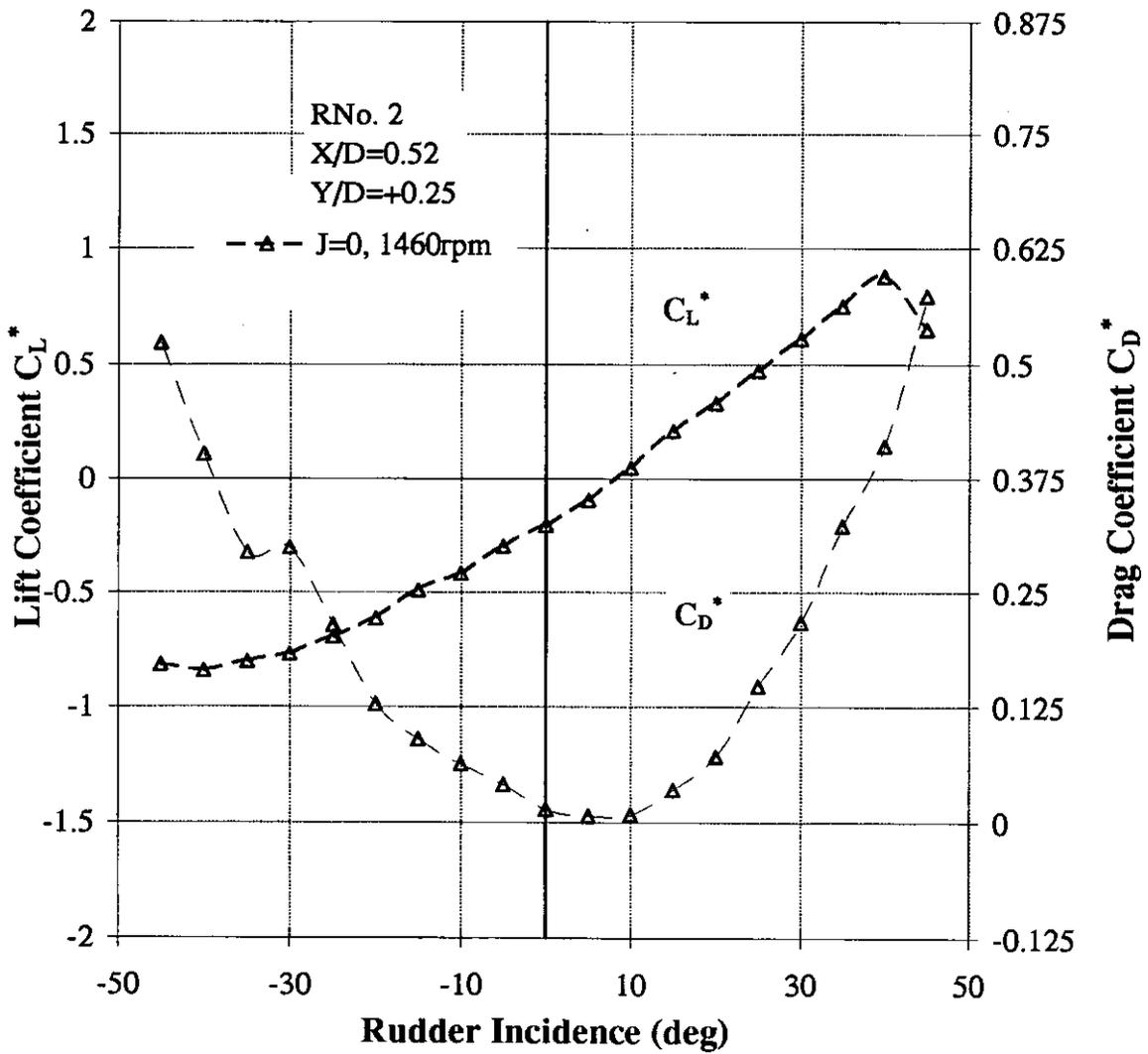
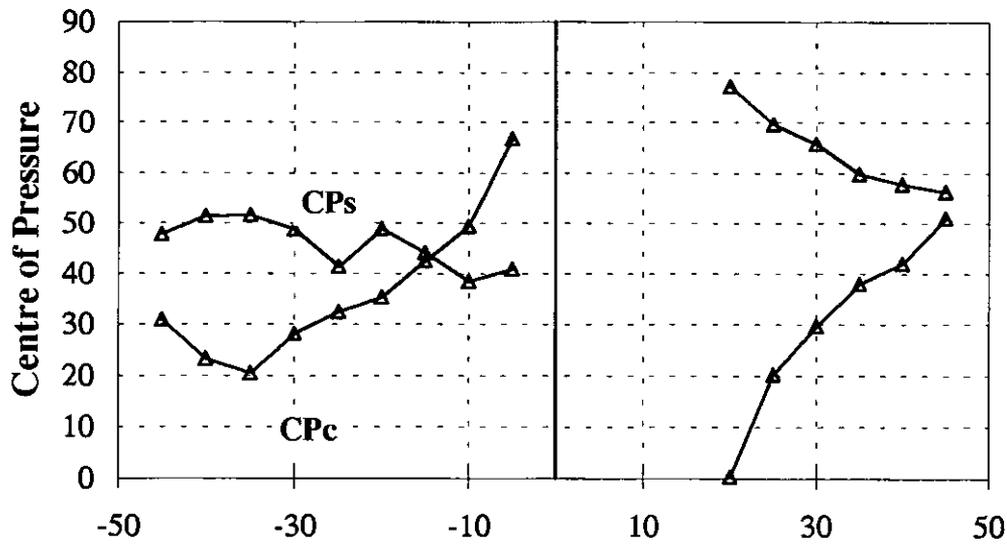


Fig. 30 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of All-Movable Rudder No. 2 at a Lateral Separation of $Y/D=+0.25$ and a Longitudinal Separation of $X/D=0.52$.

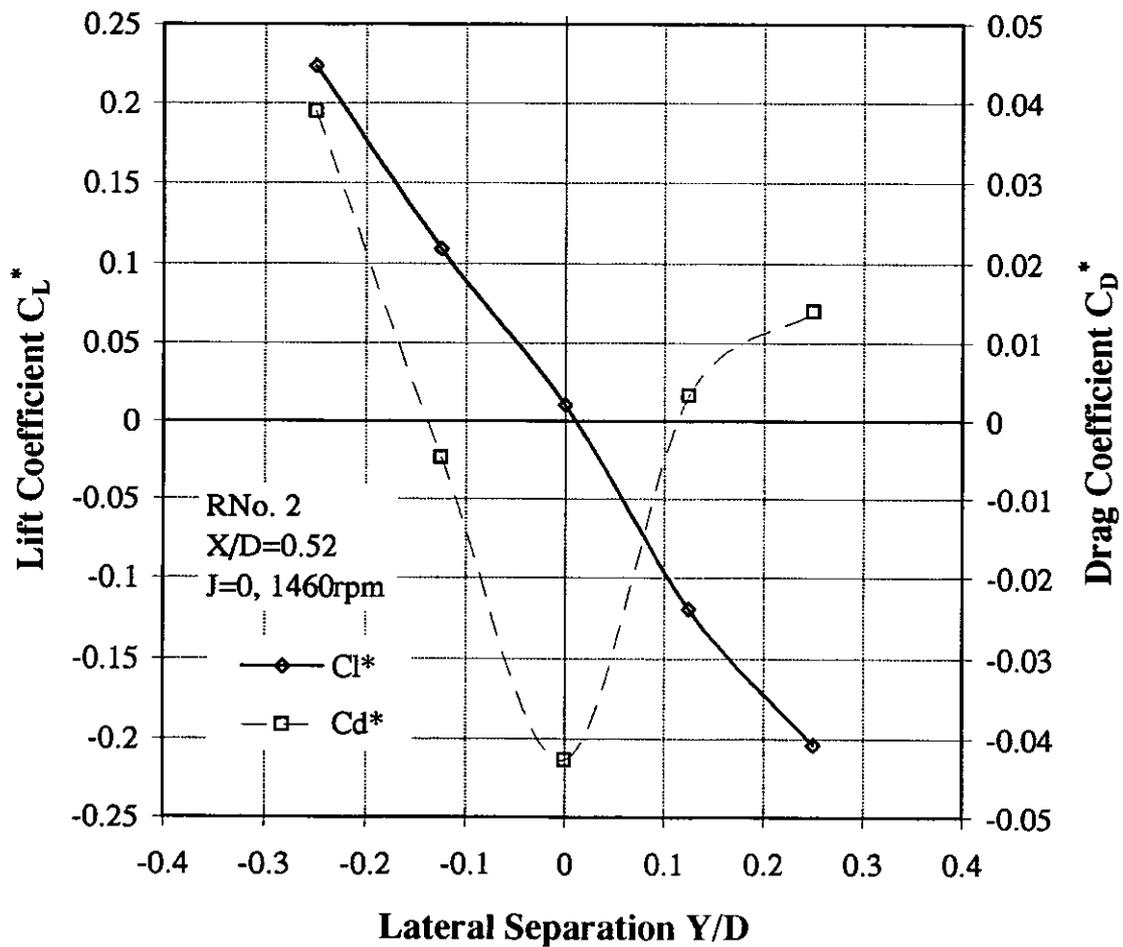


Fig. 31 Influence of Lateral Separation (Y/D) on Lift and Drag at Zero Incidence and X/D=0.52 of All-Movable Rudder No. 2 at Zero Advance Ratio (J=0)

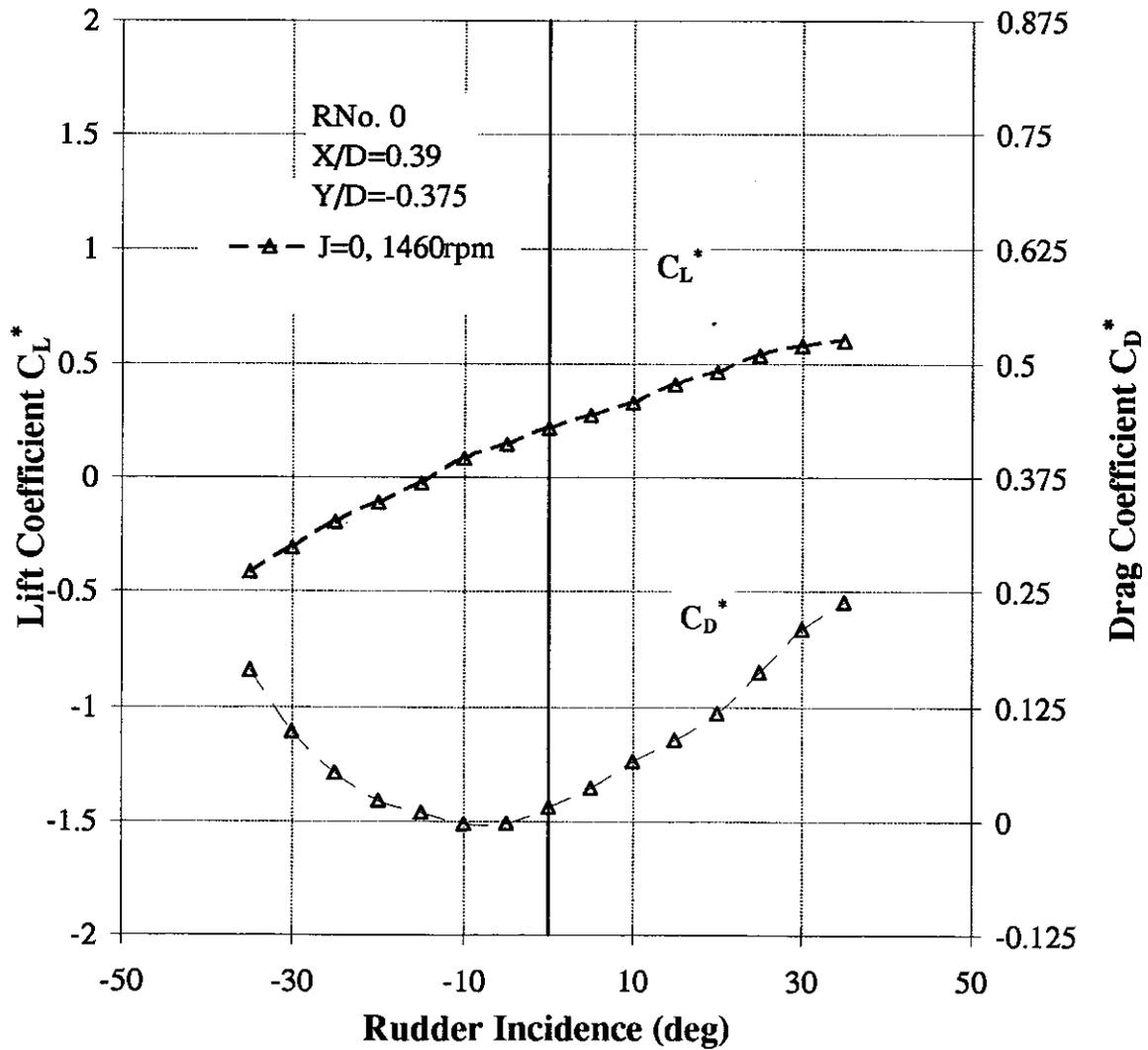
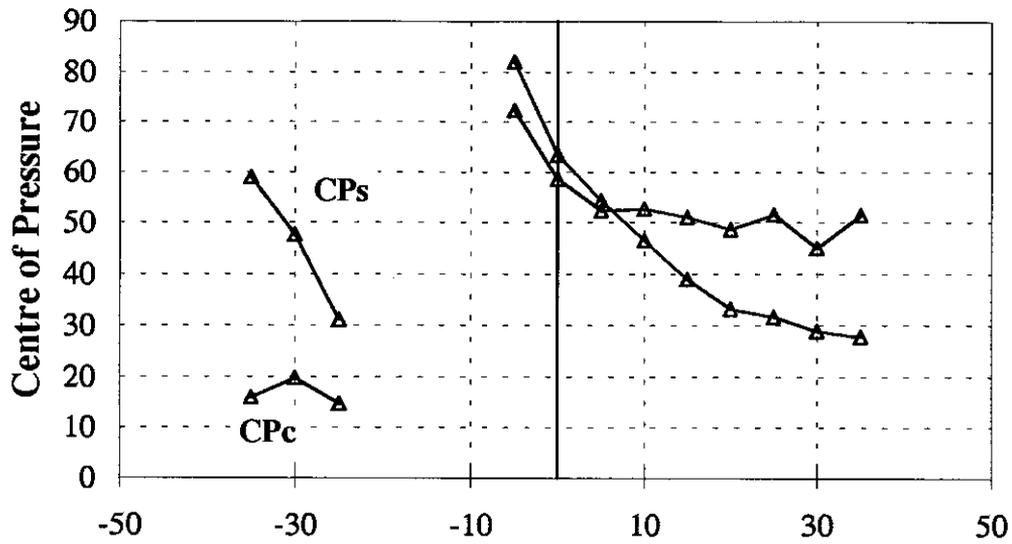


Fig. 32 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Lateral Separation of $Y/D=-0.375$.

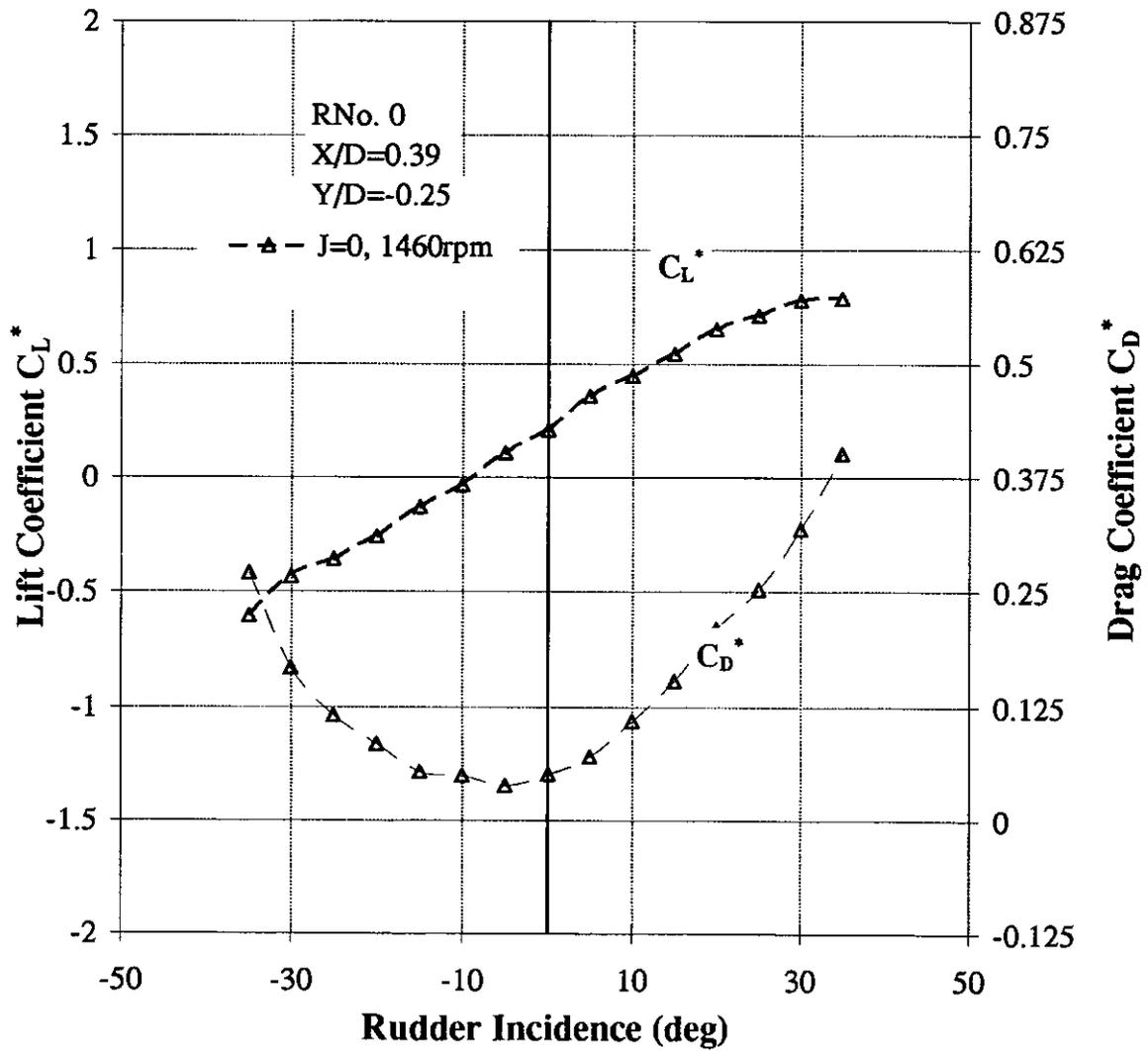
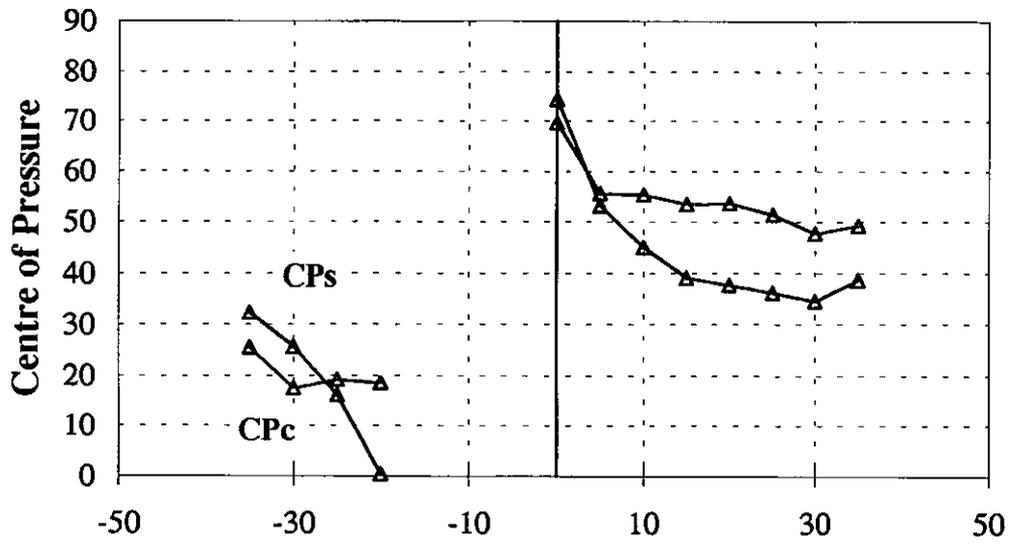


Fig. 33 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Lateral Separation of $Y/D=-0.25$.

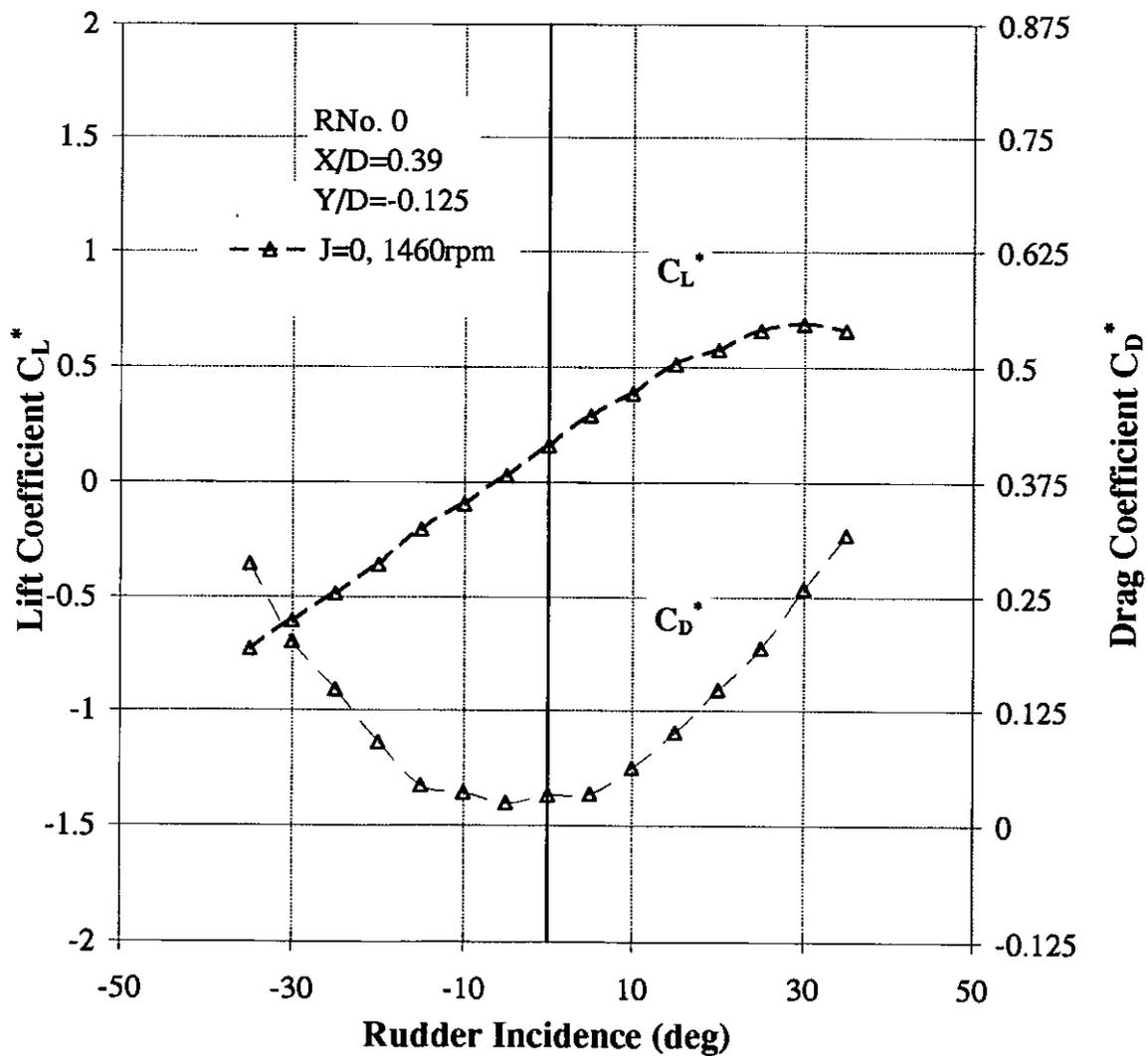
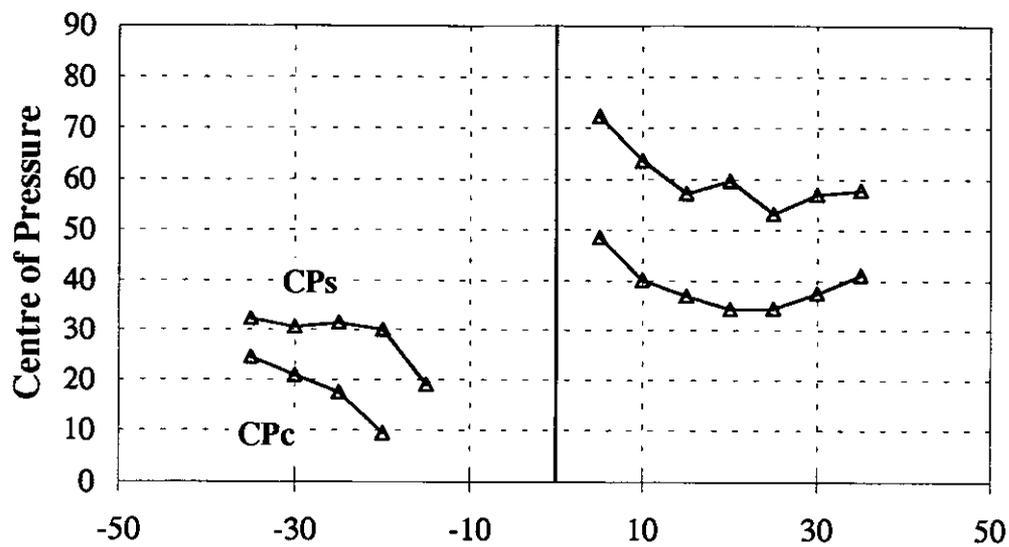


Fig. 34 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Lateral Separation of $Y/D=-0.125$.

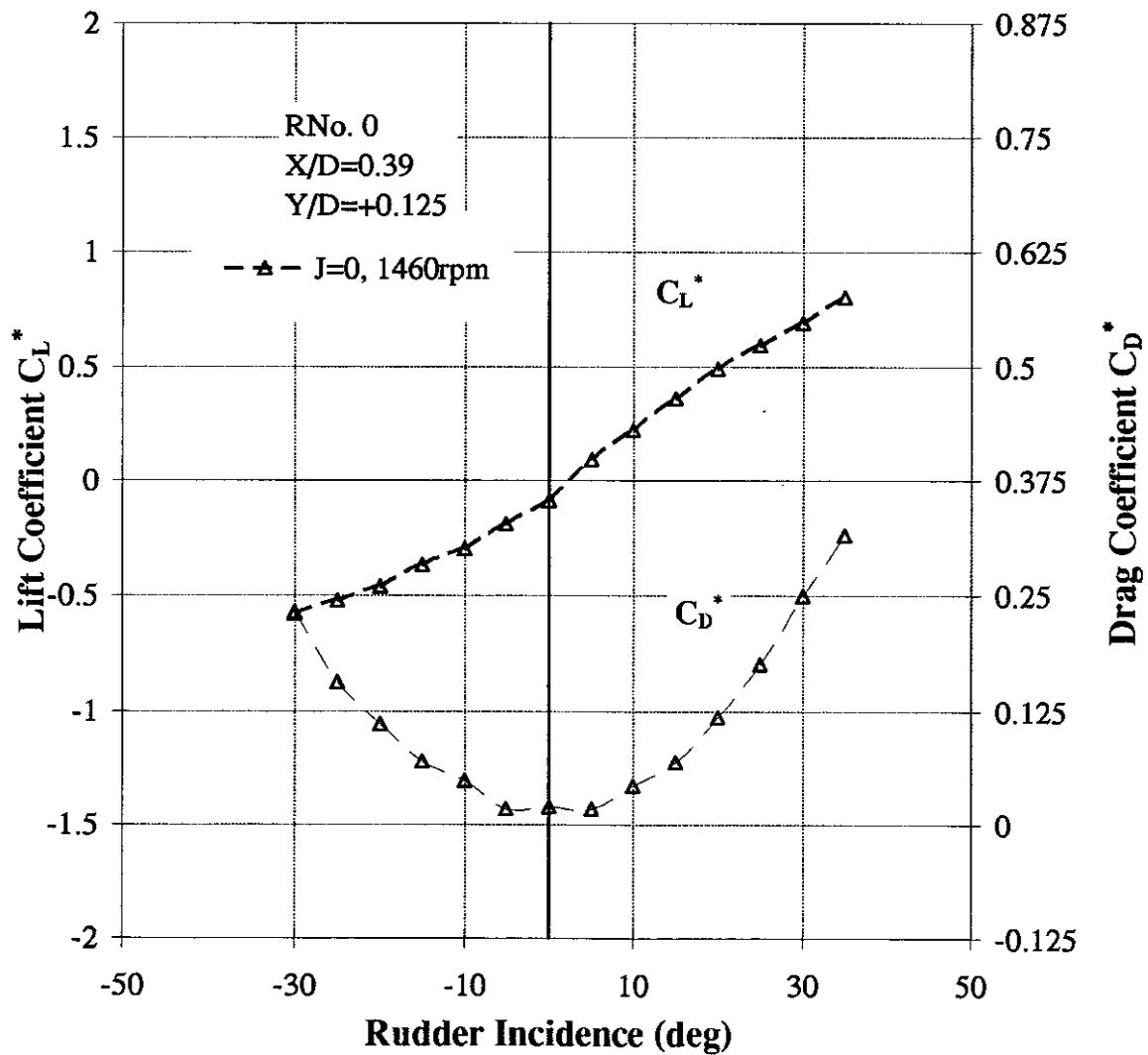
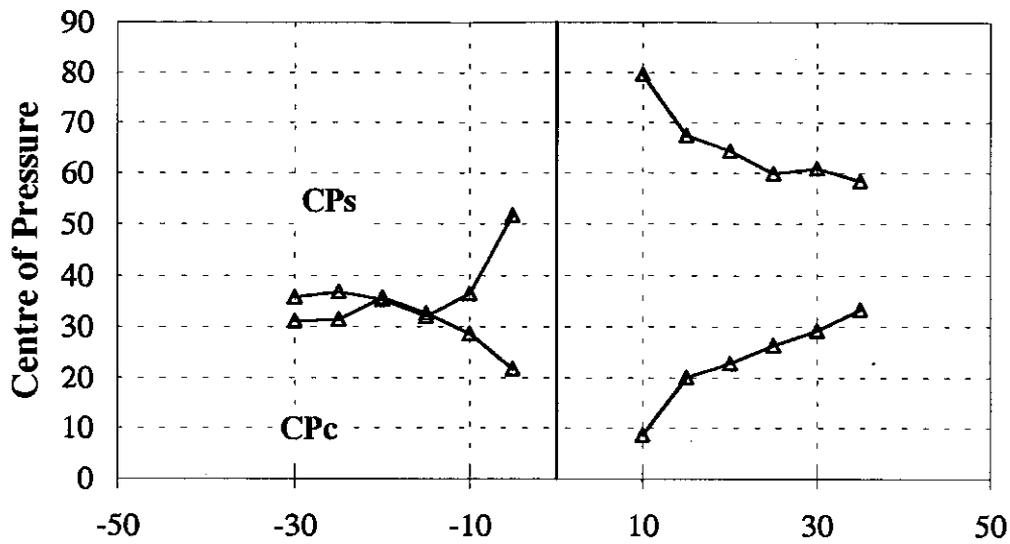


Fig. 35 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Lateral Separation of $Y/D=+0.125$.

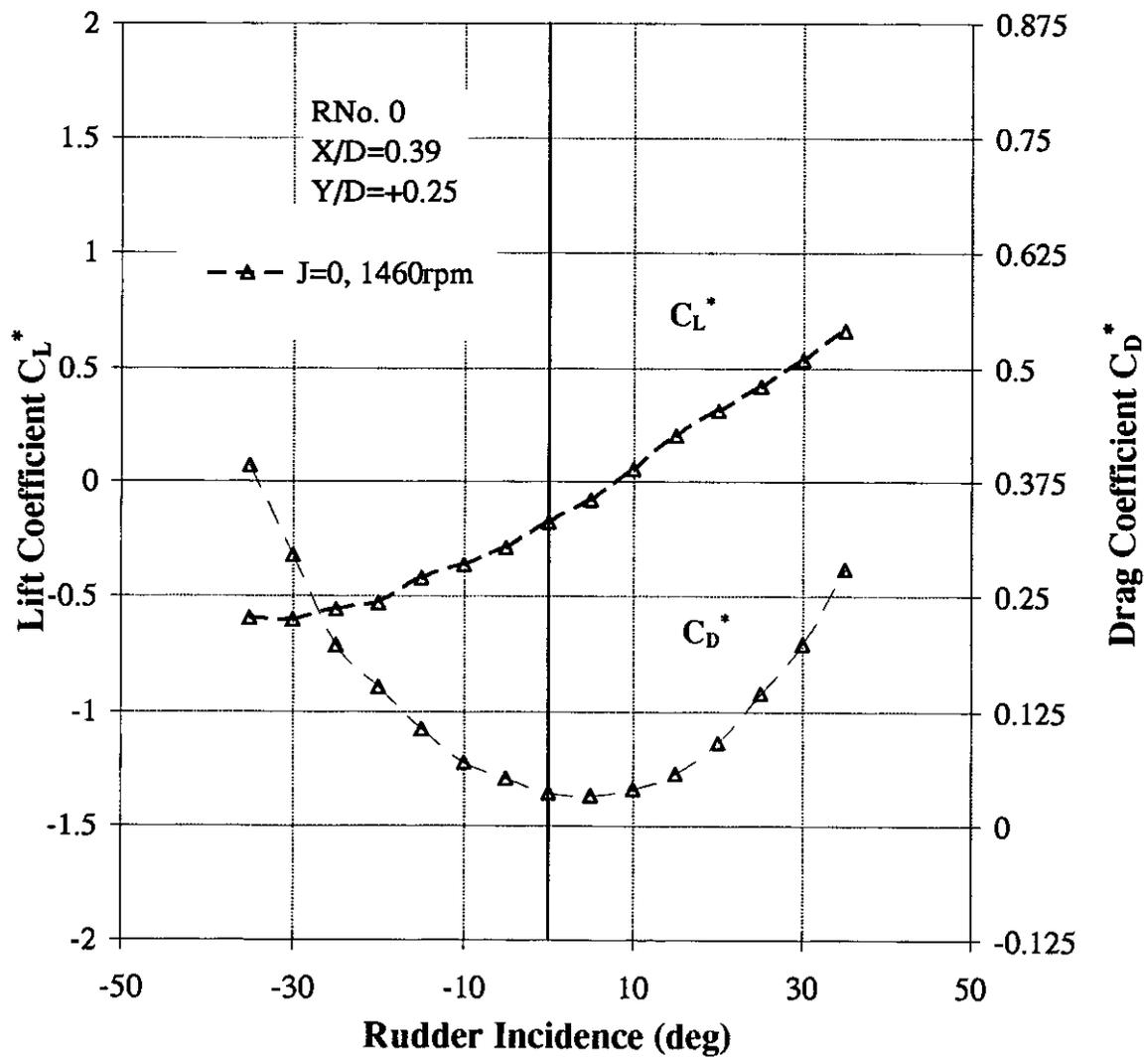
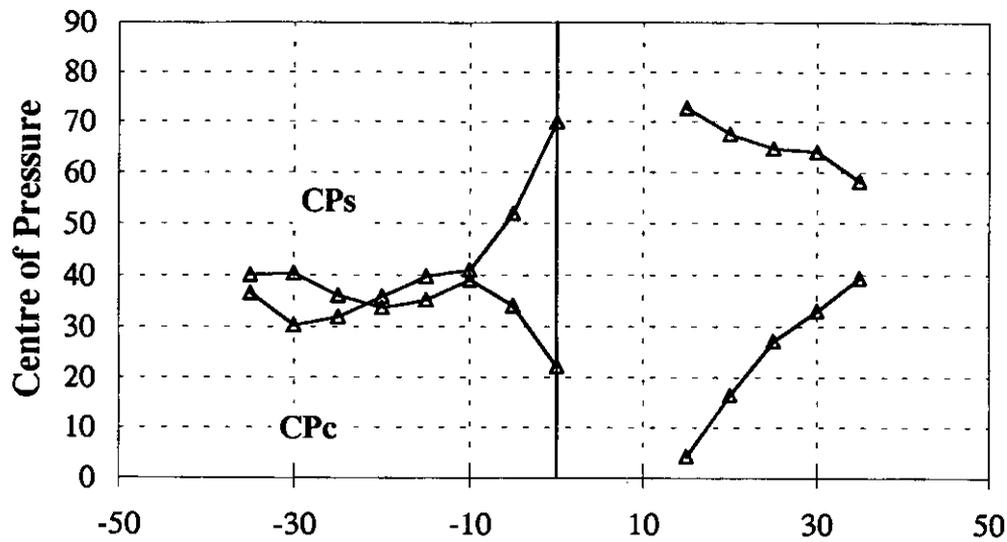


Fig. 36 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Lateral Separation of $Y/D=+0.25$.

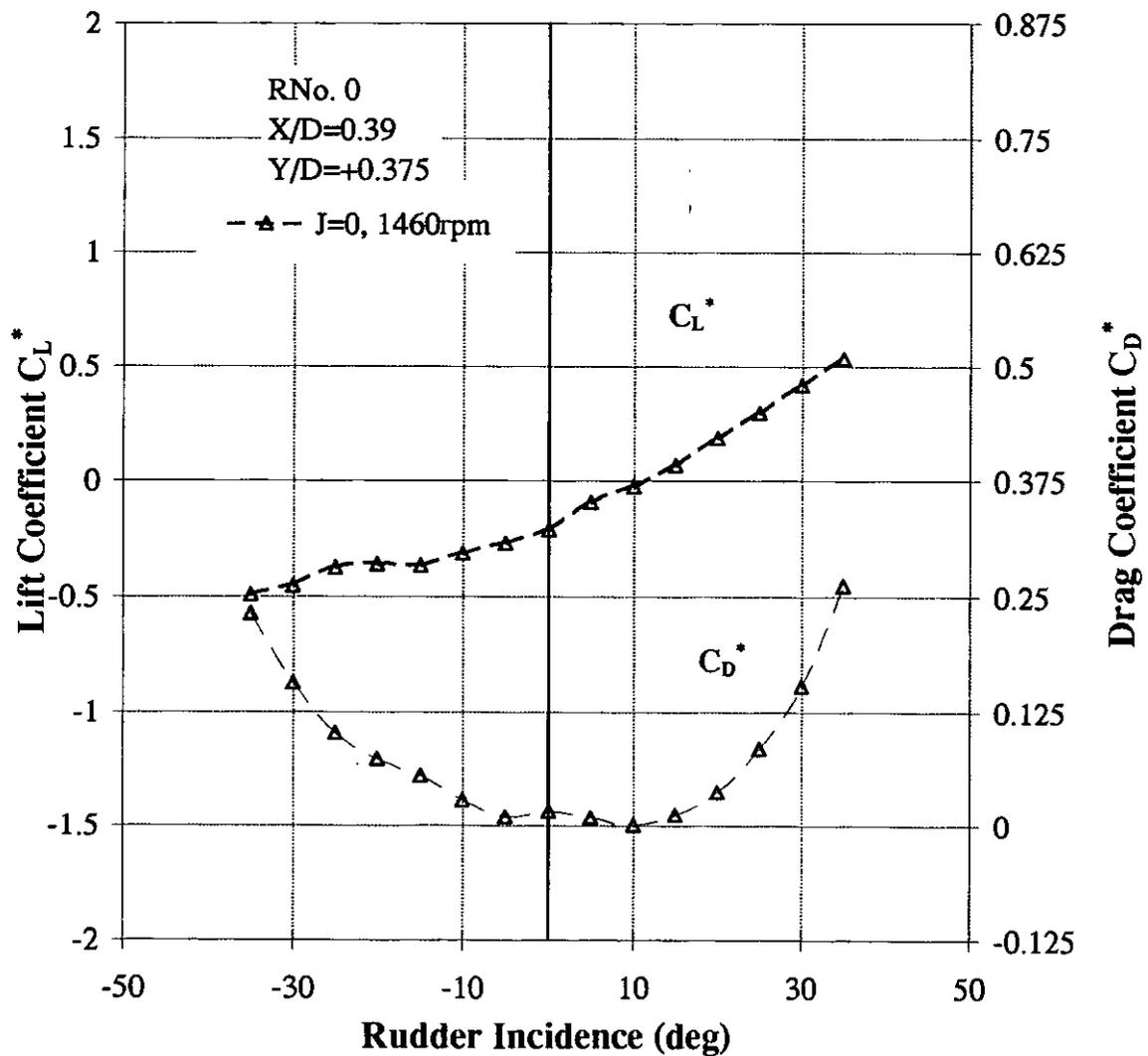
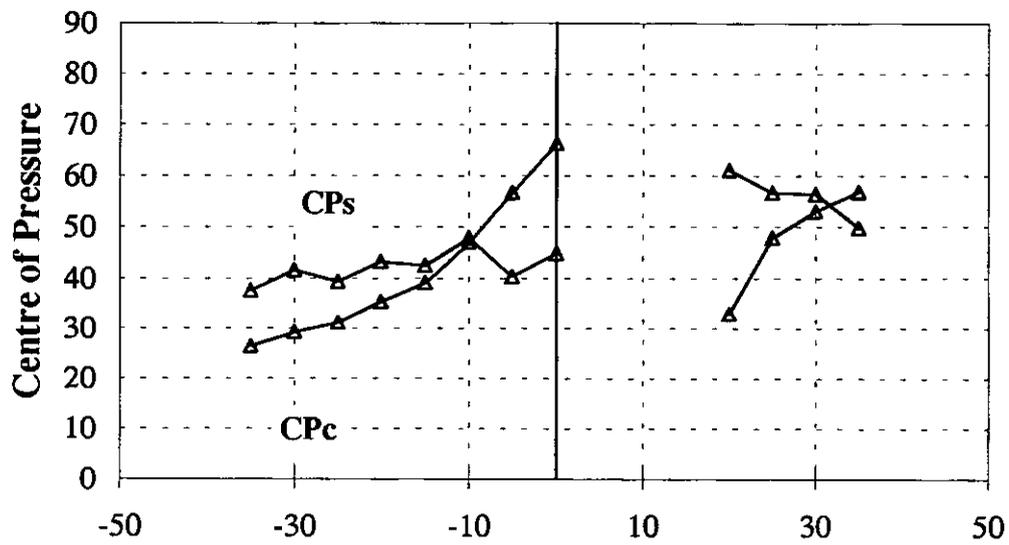


Fig. 37 Influence of Propeller at Zero Advance Ratio ($J=0$) on the Performance of Skeg-Rudder No. 0 at a Lateral Separation of $Y/D=+0.375$.

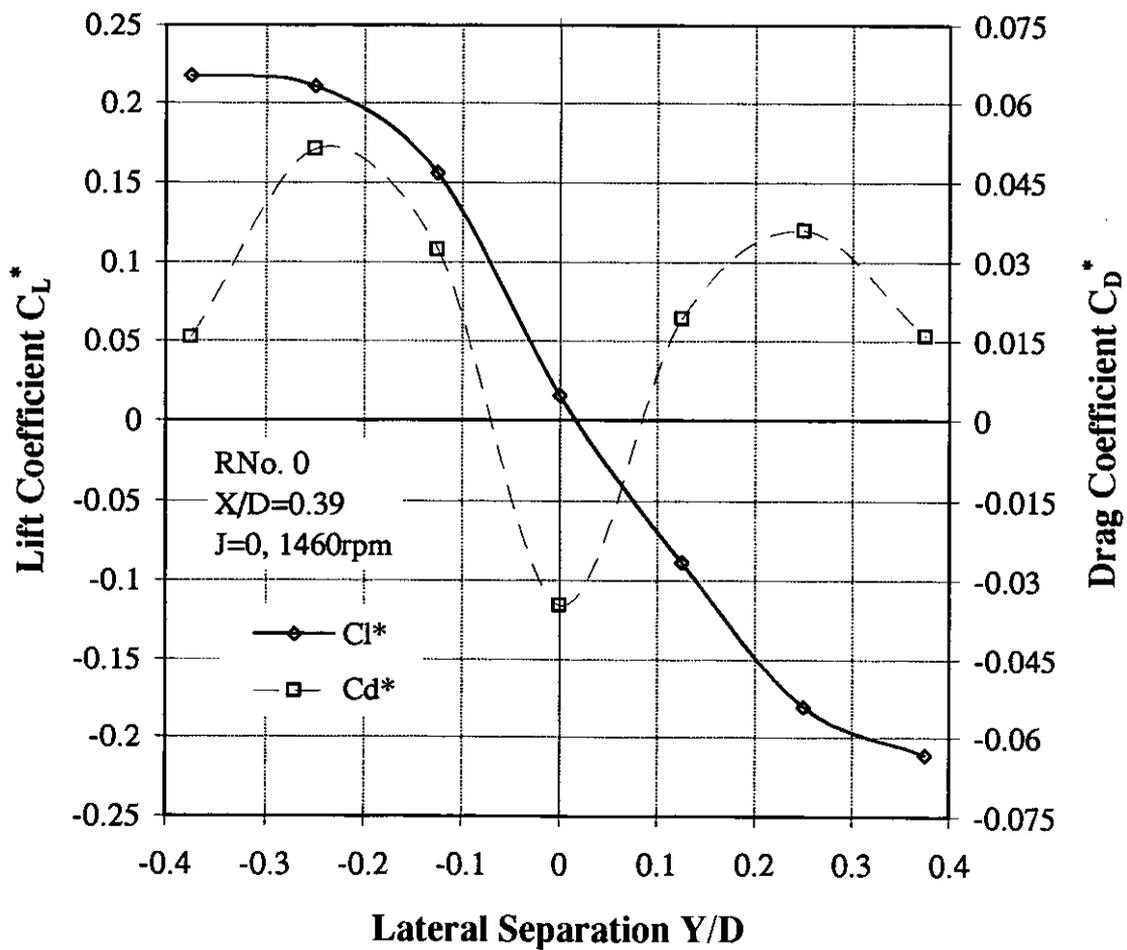


Fig. 38 Influence of Lateral Separation (Y/D) on Lift and Drag at Zero Incidence of Skag Rudder No. 0 at Zero Advance Ratio ($J=0$).

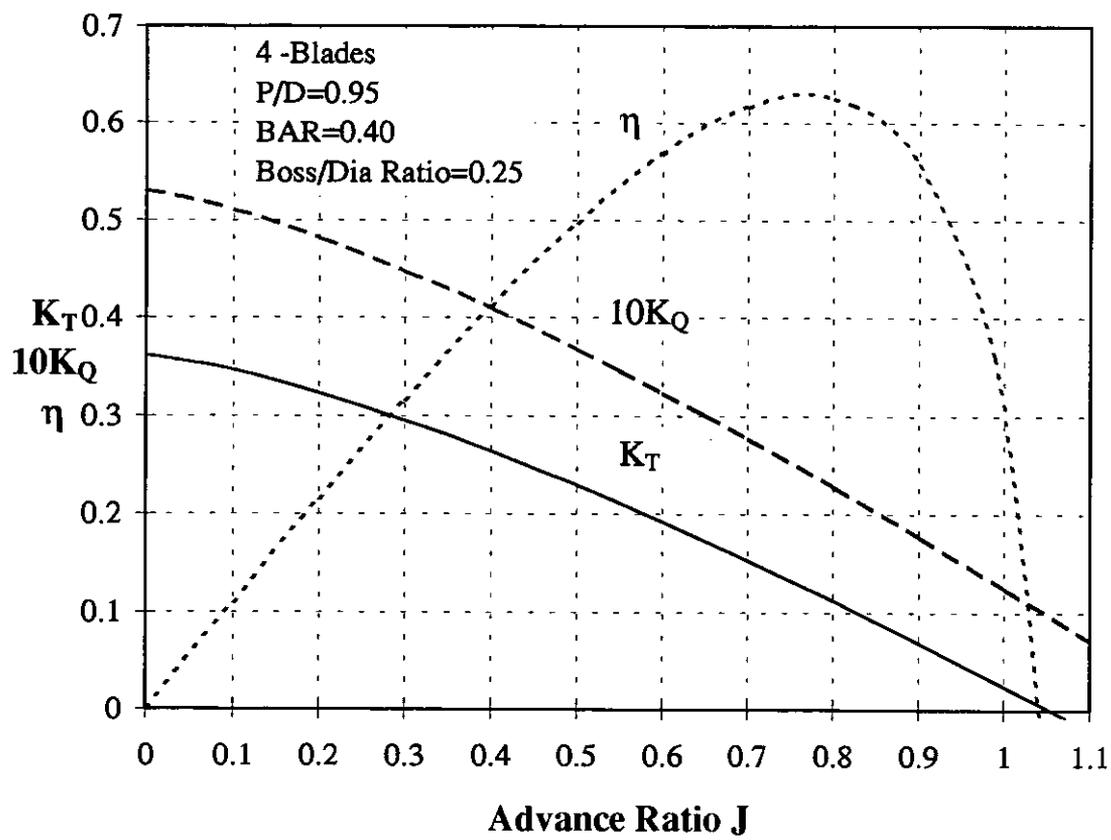


Fig. 39 Freestream (Open Water) Propeller Characteristics of Modified Wageningen B.4.40 at a mean Pitch Ratio of 0.95.

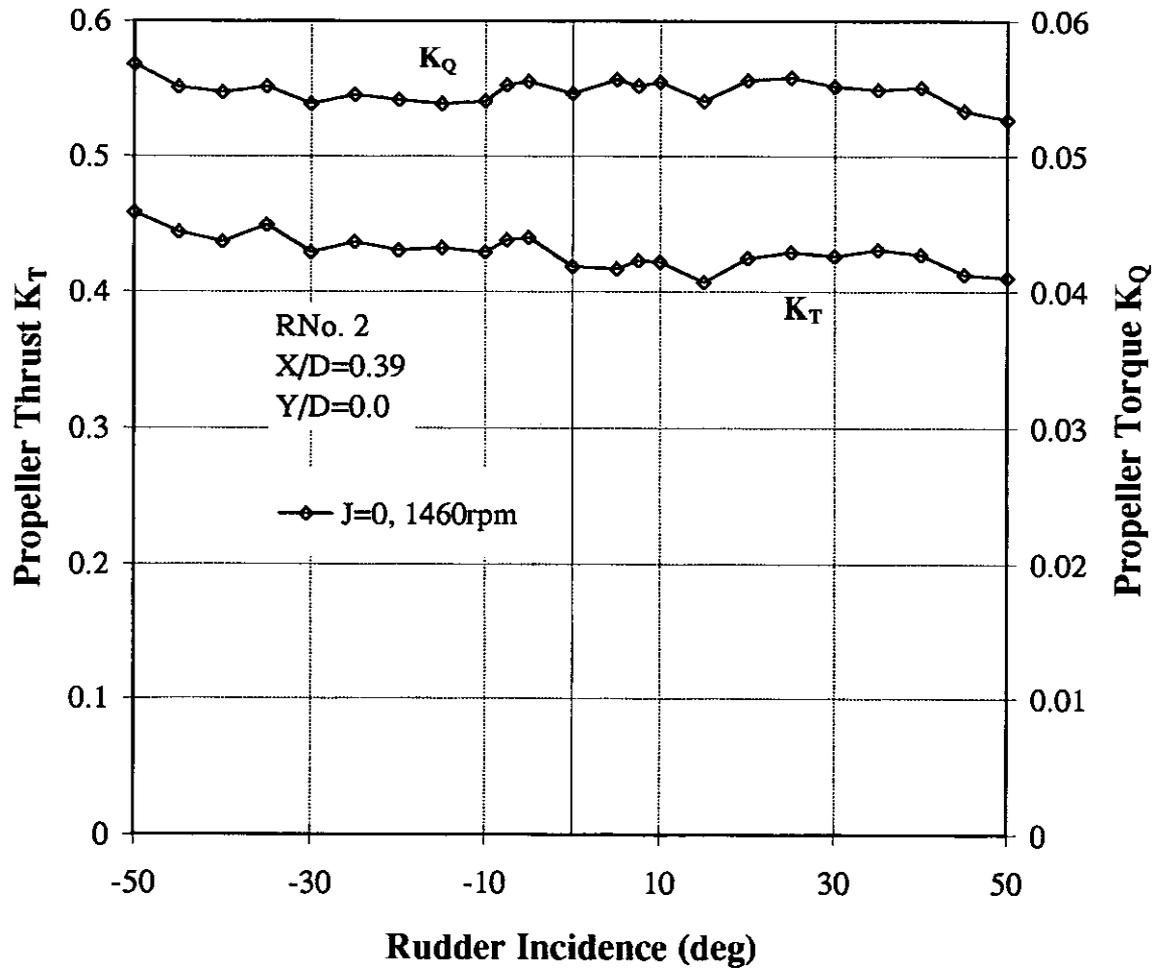


Fig. 40 Influence of All-Movable Rudder No. 2 on Propeller Thrust and Torque at Zero Advance Ratio ($J=0$)

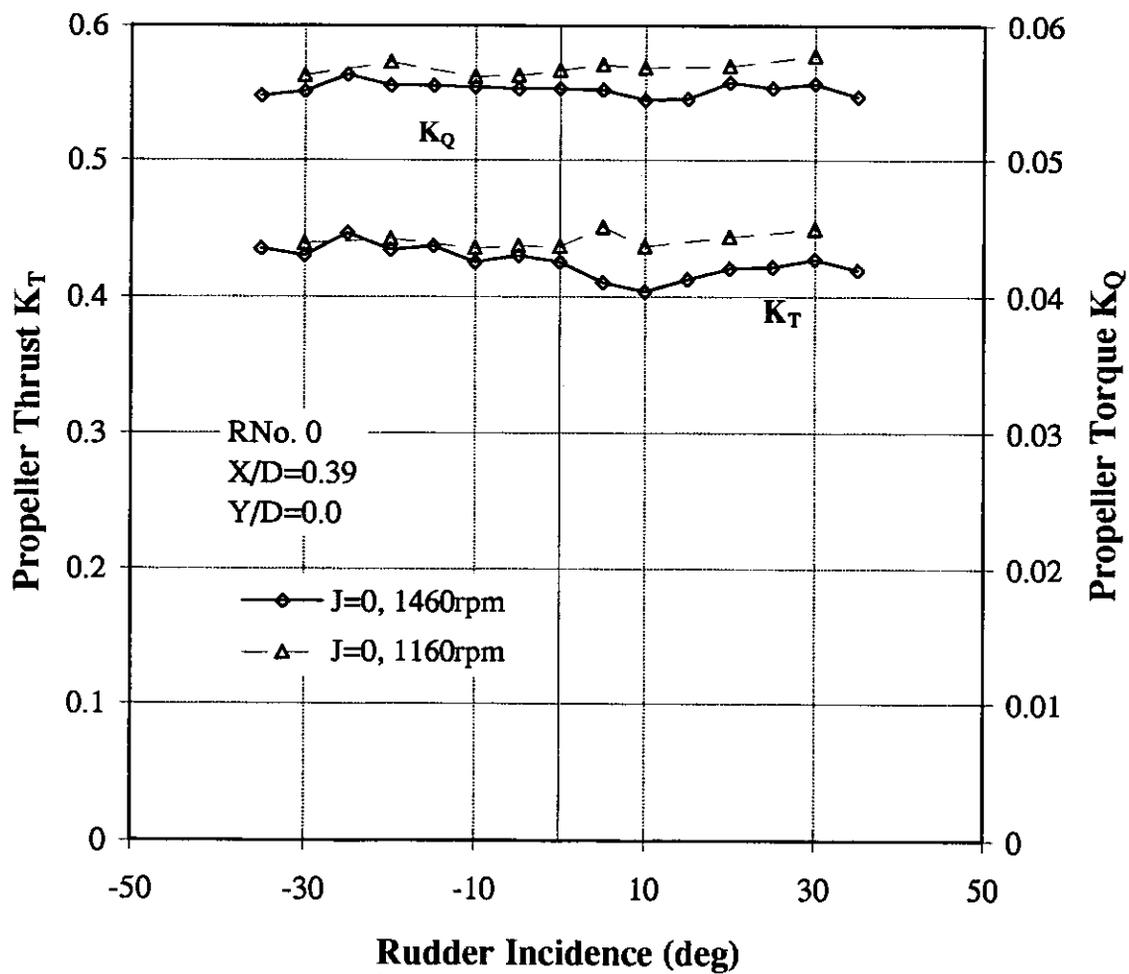


Fig. 41 Influence of Skeg Rudder No. 0 on Propeller Thrust and Torque at Zero Advance Ratio ($J=0$)



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Central Reprographic Service
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