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Local Velocity Field Measurements around the KCS Model (SRI M.S. No. 631) in the SRI 400m Towing Tank

Report of Ship Performance Division

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Research on Quality Control for Evaluating Propeller Performance

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1. Introduction

The present report describes the local velocity field measurements around a model of a Korea Research Institute of Ships and Ocean Engineering (KRISO) 3,600TEU container ship (KCS) for the International Workshop on CFD in Ship Hydrodynamics, Gothenburg 2000. The Ship Research Institute (SRI) was asked to provide validation data on this ship to the workshop. The purpose of this investigation is to obtain reliable experimental data on the local velocity field around a modern and practical hull form ship with a bulbous bow, transom stern and stern bulb.

The information on geometrical shape and the experimental conditions of the KCS [1] was provided by KRISO. The ship model was manufactured at the SRI model workshop based on the lines drawn by KRISO and a Japanese company and made by a different manufacturing method and materials.

The measurements were performed at the SRI 400m towing tank. The propeller model, SRI M. P. No.460, was offered from KRISO to use for self-propulsion tests, surface pressure on the hull and local velocity field measurements. The local velocity field measurements were conducted at two stations around the stern including the propeller plane. One of the measurements was performed immediately behind the propeller, that is, 0.25 diameters downstream of the propeller plane under the propeller working condition.

The measurement results obtained through the present careful experiments could provide valuable information for the CFD and EFD community.

2. Experimental Setup

2.1 Ship Model

The principal particulars and the geometrical hull form shape of the ship model, SRI M. S. No. 631 are given in **Table 1** and **Fig. 1**, respectively. The ship model was manufactured to the same size as that used at KRISO, and was made of a combination of paraffin and wood.

The lines of this ship model were slightly modified and drawn by SRI and a Japanese company based on the lines given by KRISO with a scale ratio of 31.5994, so as to be able to manufacture the model at the SRI model workshop. A noticeable difference in the lines drawn at SRI and KRISO could be observed mainly around the bulbous bow and flat stern hull above the propeller.

Unfortunately the ship model made at SRI shrank non-uniformly by about 5mm in the longitudinal direction, especially around the aft body. The deformation in other directions was within 1mm and occurred primarily during the first measurement at the SRI 400m towing tank.

In spite of slight modification of the lines and deformation of the ship model, reasonable correlation on the local velocity field measurements at the propeller plane was found between the SRI and KRISO data [1].

The square station (S.S.) described in this report is defined as the length between the fore and the aft perpendiculars divided by 10, and the aft and the fore perpendiculars are denoted as S.S. 0 and 10, respectively. The maximum sectional area of this ship is located at S.S. 4 3/4, not at the midship, that is, S.S. 5.

Studs with trapezoidal heads for turbulence stimulation were placed at S.S. 9 1/2 and the middle of the bow bulb with 10mm intervals to make the flow around the hull fully turbulent. The height and front width of studs were 1.5mm. The rudder shape was simplified and made to measure rudder forces not only in resistance tests but also in self-propulsion tests as shown in **Fig. 1** but not attached during the present measurement.

The present model was also used for resistance tests [2], self-propulsion tests [2], wave profile measurements [3], local velocity field measurements, and surface pressure measurements [4]. For the surface pressure measurement, 161 pressure taps were equipped on the hull mainly from S.S. 3 to S.S. 1/4 on the port side of the model. The measurements on the propeller plane were conducted before the equipment of pressure taps.

2.2 Propeller Model

The principal particulars and the geometrical shape of the propeller model, SRI M. P. No. 460 (KRISO KP505) are given in **Table 2** and **Fig. 2**, respectively. This model was manufactured by KRISO and sent to SRI for rental use. The curves of propeller open water characteristics measured at SRI [5] are shown in **Table 3** and **Fig. 3**. The measured thrust K_T and torque K_Q at SRI are larger than those measured at KRISO at the same advance ratio J. The propeller model was equipped at x/L=0.4825, that is, 0.0175L (127.3mm) upstream from A.P.

2.3 Experimental Apparatus

The measurements were performed at the SRI 400m towing tank with dimensions of 400m in length, 18m in breath and 8m in depth. The maximum speed of the towing carriage was usually 15 m/sec in the 1960's, but it is currently around 12m/s. The adjustment of the draft of a ship model was made in the trimming tank through glass windows.

For three-dimensional velocity field measurements around the stern, a spherical type eight-hole Pitot tube was employed. The diameters of the probe and each hole are 8mm and 0.6mm, respectively. A drawing of the probe shape is shown in **Fig. 4**. The calibration of the Pitot tube [6] was carried at the SRI 400m towing tank.

The calibration curves are shown in **Fig. 5**. The present calibration was carried out by simply changing the angle of the Pitot tube relative to the vertical and horizontal directions independently. The Pitot tube was calibrated at 48 angles in the range from – 35 to 60 degree pitch and from – 35 to +35 degree yaw, keeping the other angle zero. Such a calibration was not sufficient to get accurate calibration curves for an eight-hole Pitot tube used for local velocity field measurements. The calibration coefficients to determine the magnitudes and angles of local flow for the current experiment were used by assuming a similarity in each coefficient, but will be improved in the future.

A two-dimensional traversing system was installed on the ship model and one Pitot tube scanned the vertical planes including the propeller disk. This device is equipped with a balancing weight to prevent heel of the ship model due to the traverse of a Pitot tube.

Eight holes of the Pitot tube were connected to each pressure transducer by vinyl tubing whose inner and outer diameters were 1.6 and 2.0 mm, respectively. Eight semi-conductor type pressure transducers (Toyoda PD104, capacity; 3,000mmAq) were used and connected to separate amplifiers. The pressure signals were amplified 500 or 1,000 times by eight measuring amplifiers (Toyoda AA3004 and 3000). The cut-off frequency of the low pass filters (Kyowa LFV-21A) was set to 20Hz. The filtered signals were monitored by a multi-pen recorder (Graphtec MC 6625) and the un-filtered pressure signals were recorded by an analogue data recorder (Kyowa RTP-650B) at a tape speed of 1.2cm/s and over a frequency range of DC to 625Hz.

The data acquisition of mean velocities was made by a personal computer through an A/D signal board where the sampling rate and period were 100Hz and 5 seconds, respectively. The measured signal was simply averaged and normalized by the ship speed U.

To measure the relative speed of the ship model to the tank water during each run, a turbine meter was set 171mm below the tank water level corresponding to half of the draft and 10.9m in front of the ship model. In order to correct for the effect of variation in the rail height and tank water level during the present measurement, a reference Pitot tube was utilized.

3. Experimental Procedure and Conditions

The measurements of wave profile and local velocity field on the KCS were carried out at the KRISO towing tank under fixed conditions. The trim and sinkage of the ship model were not allowed at the given draft using two clamping devices. This method could not be applied to the measurement at the SRI 400m towing tank due to a leakage of tank water.

In order to conduct the measurements under similar experimental conditions to the KRISO measurements, the initial trim and the weight arrangement were sought by a trial and error method to realize zero trim and sinkage of the ship model in a free running condition. This condition of the ship model was called the even keel condition. The carriage speed relative to the ground was kept at 2.196m/s corresponding to Fr=0.2600 under the even keel condition.

The measurements were performed by adjusting the displacement of the model to the given value, 1,649.0kg. The weight of the traversing system and a Pitot tube was 57.4kg. A weight of 1kg was used as the balancing weight in the present case. When the Pitot tube traversed

420mm to the port side (from the center line), the ship model heeled by around 0.3mm. Measurements at 7~11 positions were possible during one carriage run.

All of the measurements were performed without a rudder. Under the resistance test condition, that is, the without propeller condition, total resistance coefficient C_{TM} and residuary resistance coefficient C_R were estimated to be 0.003534 and 0.0006888, respectively. Reynolds number Re was $1.362x10^7$ at 13.9°C. The density of tank water ρ was assumed to be $101.88kg*s^2/m^4$ in this report.

The revolution rate of the propeller model was set to 9.5rps with an even keel and self-propulsion condition at the "ship point", that is , the ship self-propulsion condition. The thrust K_T and Torque coefficients K_Q were 0.1703 and 0.02880, respectively. Thrust loading coefficient C_{Th} was 0.5074 and advance coefficient J was estimated 0.728 from the propeller open water characteristics curves measured by SRI as shown in Fig.3. Re was $1.348x10^7$ at 13.5°C.

4. Results of Local Velocity Field Measurement

4.1 Measured Quantities

In the present measurement, each head of the eight-hole Pitot tube, the speed of the ship model relative to the tank water, the resistance, the dipping at both perpendiculars and the heel were measured. Additionally thrust and torque were measured in the self-propulsion condition. The heel was measured by an inclinometer.

In the presentation of the measurements, a Cartesian coordinate system was adopted and the x-, y-, z- axis are in the direction of aftship, starboard side of the hull, upper desk, respectively. The origin was defined to be at the intersection of the water plane at load water line and the midship.

A few measured values under the propeller operating condition were discarded because the local flow angle was out of the calibration range. The measurements at SRI were carried out in two planes, the propeller plane (x/L=0.4825) and 0.25 diameter behind the propeller (x/L=0.4911).

4.2 Measurements in the Propeller Plane

First of all, measurement of the local velocity field was carried out in the propeller plane to compare with the data from the KRISO towing tank. The measurements in the even keel condition with a 40mm traverse step are shown in **Fig. 6**, along with the KRISO data mainly with a 20mm traverse step. The present measurements are so coarse that the agreement with KRISO data seems to be not so good. However, if the KRISO data at the points not measured at SRI are added to the SRI data or data only at the points measured at SRI are compared with SRI data, reasonable agreement between them was observed. Therefore, more detailed measurements with a 20mm traverse step at SRI would give better agreement on the measured local velocity field between the two measurements.

Nominal wake fractions, 1-w_N at the even keel conditions were 0.686 at SRI and 0.709 at KRISO. The coarse measurement at SRI would cause the deference in wake faction, because by more detailed measurements nominal wake fraction was 0.712 [7].

4.3 Measurement at 0.25D behind the Propeller Plane

Two measurements of local velocity field without and with working propeller model at an even keel condition were carried out at 0.25D behind the propeller plane not only on the port side but also the starboard side. The measured results looking upstream are shown in **Figs. 7** and **8**.

Fig. 7 shows the measurements of the local velocity field without a propeller. The measured velocity field shows reasonable symmetry with respect to the centerline of the ship model. Except on the centerline, upward flow from the bottom was observed. Near the centerline above the propeller shaft, downward flow was found. On both sides near the upper corner of the propeller boss, a weak vortex flow was found.

Under the propeller working condition, clockwise rotational flows generated by the propeller model appeared in the propeller slipstream, especially on the port side. Around 0.5 – 0.7 radius positions above the propeller shaft on the starboard side, circumferential flows disappeared and only axial flows were observed due to the interference between rotational flows by the propeller and wake as shown in **Fig. 8**.

5. Concluding Remarks

This report describes the measurements of local velocity field around a modern and practical 3,600TEU container ship. The ship model was manufactured at the SRI model workshop by using the lines offered by KRISO but used a different manufacturing method and materials. In spite of slight modification of the lines and deformation of the ship model, reasonable correlation on the local velocity field measurements at the propeller plane was found between the SRI and KRISO data.

The local velocity field measurements immediately behind the operating propeller, 0.25 diameters downstream of the propeller plane and those without a propeller behind the ship model were obtained. It is expected that the data will be useful data for validating CFD computations.

In the present experiments, the calibration coefficients for an eight-hole Pitot tube were obtained by a simple calibration and used for analyzing the magnitudes of velocity and flow angles of the wake behind not only the ship model but also the working propeller model. It is assumed that the averaged values of the velocities measured by the Pitot tube were not affected by unsteady velocity fluctuations.

Repeat tests [7] were performed to carry out uncertainty analysis and the results will be published in near future.

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Nomenclatures

A_M	Midship Section Area [m^2]
A_0	Propeller Disk Area [m^2], $=(\pi Dp^2)/4$
a_E	Expanded Area Ratio [-]
B	Breadth of Ship [m]
C_B	Block Coefficient [-]
C_F	Frictional Resistance Coefficient [-], $=R_F/(1/2\rho U^2 S_W)$
C_M	Midship Section Coefficient [-], $=A_M/BT$
C_P	Pressure Coefficient [-], $=(P- P_O)/(1/2\rho U^2)$
C_P	Prismatic Coefficient [-], $=\nabla/ (A_M L_{PP})$
C_R	Residuary Resistance Coefficient [-], $=R_R/(1/2\rho U^2 S_W)$
C_{Th}	Thrust Loading Coefficient [-], $=T/(1/2\rho U^2 A_0)$
C_{TM}	Total Resistance Coefficient [-], $=R_{TM}/(1/2\rho U^2 S_W)$
D	Depth of Ship [m]
D_p	Propeller Diameter [m]
d	Draft of Ship [m]; T
F_h, F_{h8}	Function to determine Horizontal components of Flow Angle for Each Five-Hole System [-]
F_v, F_{v8}	Function to determine Vertical components of Flow Angle for Each Five-Hole System [-]
F_r	Froude Number Based on Length between Perpendiculars, L; F_n, $=U/(gL)^{1/2}$
G_h, G_{h8}	Function to determine Horizontal component of Inflow Velocity [-]
G_v, G_{v8}	Function to determine Vertical component of Inflow Velocity [-]
g	Acceleration of Gravity [m/s^2]
H_T,H_B,H_C,H_P,H_S,H_{T1},H_{P1},H_{S1}	Head at Each Pressure Hole, T, B, C, P, S, T_1, P_1 and S_1 of Eight-Hole Spherical Type Pitot Tube [Aq]
I	Propeller Immersion [m]
J	Advance Coefficient [-], $= V_A / n_P D$
K_Q	Torque Coefficient [-], $=Q/\rho n_P{}^2 D^5$
K_T	Thrust Coefficient [-], $=T/\rho n_P{}^2 D^4$
L	Length between Perpendiculars [m]; L_{PP}
L_{PP}	Length between Perpendiculars [m]; L
L_{WL}	Length at Load Water Line [m]
l_{CB}	Center of Buoyancy from Midship [%L_{PP}, Backward +]
N	Number of Individual Readings [-]
n_P	Propeller Revolution Rate [1/s, Hz]
P	Pressure [kg/ m^2]

P_O	Reference Pressure at Infinity [kg/ m^2]
p	Pitch Ratio [-]
R_e	Reynolds' Number Based on Length between Perpendiculars [-]
R_F	Frictional Resistance [kg]
R_R	Residuary Resistance [kg]
R_T	Total Resistance [kg]
S_R	Wetted Surface Area of Rudder [m^2]
S_W	Wetted Surface Area of Naked Hull without Rudder [m^2]
T	Draft of Ship [m]; d
T_W	Temperature of Tank Water [°C]
U	Speed of Ship Model [m/s]
u,v,w	Local Mean-Velocities in (x,y.z) directions
V_A	Propeller Advance Speed [m/s]; =(1-w_T)U
V_e	Speed of Ship Model to the Ground [m/s]
V_h	Horizontal Component of Inflow Velocity to Pitot Tube [m/s]
V_v	Vertical Component of Inflow Velocity to Pitot Tube [m/s]
w_T	Axial Wake Fraction determined by Propeller Thrust [-]
x	Coordinate for Longitudinal Direction of Ship [m]
x_B	Propeller Boss Ratio [-]
y	Coordinate for Transverse Direction of Ship [m]
Z	Number of Blade [-]
z	Coordinate for Vertical Direction of Ship [m]
β_h	Flow Angle between Horizontal Component of Inflow and X-Axis [deg]
β_v	Flow Angle between Vertical Component of Inflow and X-Axis [deg]
η_o	Propeller Efficiency [-]; =(JK_T)/(2πK_Q)
Θ_R	Rake Angle [deg]
Θ_S	Skew Angle [deg]
θ	Sensitivity Coefficient
ν	Coefficient of Kinematic Viscosity [m^2/s]
ρ	Density of Water [kg*s^2/m^4]
∇	Displacement Volume of Ship Model [m^3]

Table 1 Principal Particulars of Tested Ship

Ship Model Name			KRISO Container Ship
SRI M. S. No.			631
KRISO M. S. No.		m	KS621
Length between Perpendiculars	L_{PP}	m	7.2786
Length of Load Water Line	L_{WL}	m	7.3568
Breadth (Moulded)	B	m	1.0190
Depth (Moulded)	D	m	0.5696
Draft (Moulded)	d	m	0.3418
Wetted Surface Area w/o Rudder*	S_W	m^2	9.4984
Rudder Surface Area	S_R	m^2	0.0741
Displacement w/o Rudder*	∇	m^3	1.6497
Center of Buoyancy from Midship (Backward, +) *	l_{CB}	% L_{PP}	1.48
Blockage Coefficient*	C_B	—	0.6508
Midship Coefficient*	C_M	—	0.9849
Prismatic Coefficient*	C_P	—	0.6608

* These values were calculated by Japanese Company

Table 2 Principal Particulars of Tested Propeller

Propeller Name			KCS Propeller
SRI M. P. No.			460 & 465
KRISO M. P. No.			KP505
Diameter	D_P	m	0.2500
Boss Ratio	x_B	—	0.1800
Pitch Ratio at 0.7R	p	—	0.9967
Expanded Blade Area Ratio	a_E	—	0.800
Rake Angle	Θ_R	deg	0.000
Skew Angle	Θ_S	deg	32.0
Number of Blade	Z	—	5
Direction of Rotation			Right
Blade Section			NACA66 Thickness +a=0.8 Camber

Table 3 Propeller Open Test Results in SRI Towing Tank

J	Kt	10Kq	Eta0
0.000	0.518	0.725	0.000
0.100	0.482	0.677	0.113
0.150	0.458	0.646	0.169
0.200	0.435	0.622	0.223
0.250	0.412	0.589	0.278
0.300	0.387	0.557	0.332
0.350	0.361	0.531	0.379
0.400	0.336	0.497	0.431
0.450	0.310	0.466	0.477
0.500	0.285	0.437	0.519
0.550	0.259	0.405	0.561
0.600	0.235	0.376	0.597
0.650	0.209	0.343	0.631
0.700	0.185	0.311	0.665
0.750	0.161	0.278	0.691
0.800	0.137	0.247	0.705
0.850	0.111	0.215	0.697
0.900	0.083	0.181	0.654
0.950	0.053	0.140	0.575
1.000	0.022	0.096	0.373
1.050	-0.012	0.046	-0.437

Table 4(a) Local Velocities at 0.25Dp behind the Propeller Plane without Propeller

y[mm]	z[mm]	u/U	v/U	w/U	y[mm]	z[mm]	u/U	v/U	w/U
-180	-340	0.9305	-0.0230	-0.0849	-100	-220	0.9119	-0.0213	-0.1323
-180	-320	0.9285	-0.0258	-0.0882	-100	-200	0.9091	-0.0326	-0.1440
-180	-300	0.9259	-0.0292	-0.0909	-100	-180	0.9004	-0.0460	-0.1501
-180	-280	0.9224	-0.0327	-0.0941	-100	-160	0.8923	-0.0590	-0.1520
-180	-260	0.9224	-0.0353	-0.0987	-100	-140	0.8746	-0.0683	-0.1493
-180	-240	0.9180	-0.0406	-0.1020	-100	-120	0.8562	-0.0712	-0.1454
-180	-220	0.9182	-0.0467	-0.1057	-100	-100	0.8212	-0.0742	-0.1387
-180	-200	0.9173	-0.0518	-0.1089	-100	-80	0.7739	-0.0769	-0.1285
-180	-180	0.9137	-0.0582	-0.1118	-100	-60	0.7153	-0.0770	-0.1183
-180	-140	0.8880	-0.0637	-0.1182	-100	-40	0.6312	-0.0659	-0.1013
-180	-100	0.8099	-0.0656	-0.1116	-80	-360	0.9196	-0.0118	-0.0884
-160	-340	0.9295	-0.0200	-0.0866	-80	-340	0.9278	-0.0041	-0.0902
-160	-320	0.9258	-0.0219	-0.0898	-80	-320	0.9200	-0.0048	-0.0945
-160	-300	0.9254	-0.0249	-0.0937	-80	-300	0.9119	-0.0064	-0.0989
-160	-280	0.9236	-0.0277	-0.0979	-80	-280	0.9014	-0.0058	-0.1046
-160	-260	0.9212	-0.0305	-0.1023	-80	-260	0.8942	-0.0074	-0.1117
-160	-240	0.9166	-0.0357	-0.1067	-80	-240	0.8892	-0.0098	-0.1209
-160	-220	0.9154	-0.0406	-0.1114	-80	-220	0.8831	-0.0150	-0.1376
-160	-200	0.9150	-0.0481	-0.1157	-80	-200	0.8725	-0.0359	-0.1554
-160	-180	0.9124	-0.0558	-0.1185	-80	-180	0.8647	-0.0531	-0.1638
-160	-160	0.9075	-0.0616	-0.1223	-80	-160	0.8600	-0.0691	-0.1635
-160	-140	0.8901	-0.0646	-0.1252	-80	-140	0.8487	-0.0760	-0.1566
-160	-120	0.8532	-0.0632	-0.1222	-80	-120	0.8302	-0.0799	-0.1470
-160	-100	0.8171	-0.0640	-0.1201	-80	-100	0.8035	-0.0829	-0.1377
-160	-80	0.7683	-0.0673	-0.1135	-80	-80	0.7663	-0.0844	-0.1293
-160	-60	0.7204	-0.0645	-0.1007	-80	-60	0.7092	-0.0822	-0.1200
-160	-40	0.6878	-0.0676	-0.0974	-80	-40	0.6160	-0.0730	-0.1033
-140	-340	0.9287	-0.0161	-0.0879	-60	-360	0.9202	-0.0095	-0.0890
-140	-320	0.9251	-0.0181	-0.0913	-60	-340	0.9239	-0.0020	-0.0909
-140	-300	0.9252	-0.0208	-0.0956	-60	-320	0.9097	-0.0006	-0.0944
-140	-280	0.9218	-0.0231	-0.1003	-60	-300	0.8969	0.0001	-0.0984
-140	-260	0.9204	-0.0267	-0.1059	-60	-280	0.8765	0.0001	-0.1029
-140	-240	0.9163	-0.0299	-0.1116	-60	-260	0.8554	-0.0135	-0.1082
-140	-220	0.9160	-0.0369	-0.1168	-60	-240	0.7772	-0.0400	-0.1067
-140	-200	0.9140	-0.0450	-0.1220	-60	-220	0.6826	-0.0466	-0.1061
-140	-180	0.9099	-0.0529	-0.1257	-60	-200	0.6407	-0.0543	-0.1073
-140	-160	0.9059	-0.0594	-0.1298	-60	-180	0.6791	-0.0768	-0.1188
-140	-140	0.8894	-0.0633	-0.1320	-60	-160	0.7421	-0.0944	-0.1284
-140	-120	0.8655	-0.0648	-0.1319	-60	-140	0.7792	-0.0966	-0.1350
-140	-100	0.8290	-0.0658	-0.1282	-60	-120	0.7878	-0.0944	-0.1288
-140	-80	0.7733	-0.0674	-0.1171	-60	-100	0.7680	-0.0911	-0.1252
-140	-60	0.7189	-0.0654	-0.1080	-60	-80	0.7396	-0.0914	-0.1164
-140	-40	0.6613	-0.0639	-0.0939	-60	-60	0.6784	-0.0851	-0.1104
-120	-340	0.9293	-0.0120	-0.0888	-60	-40	0.5982	-0.0764	-0.0996
-120	-320	0.9249	-0.0137	-0.0925	-50	-190	0.5316	-0.0646	-0.0832
-120	-300	0.9245	-0.0146	-0.0973	-50	-180	0.5533	-0.0752	-0.0883
-120	-280	0.9213	-0.0165	-0.1022	-50	-170	0.5685	-0.0779	-0.0858
-120	-260	0.9203	-0.0194	-0.1093	-50	-160	0.6344	-0.0939	-0.0892
-120	-240	0.9157	-0.0234	-0.1167	-50	-150	0.6784	-0.0996	-0.0950
-120	-220	0.9149	-0.0299	-0.1244	-50	-140	0.7018	-0.0988	-0.1005
-120	-200	0.9126	-0.0383	-0.1310	-50	-130	0.7167	-0.0995	-0.1061
-120	-180	0.9094	-0.0484	-0.1373	-50	-120	0.7379	-0.1035	-0.1096
-120	-160	0.9010	-0.0576	-0.1394	-50	-110	0.7347	-0.0966	-0.1050
-120	-140	0.8875	-0.0645	-0.1428	-50	-100	0.7375	-0.0989	-0.1113
-120	-120	0.8658	-0.0681	-0.1411	-50	-90	0.7223	-0.0967	-0.1082
-120	-100	0.8221	-0.0696	-0.1332	-40	-360	0.9172	-0.0061	-0.0889
-120	-80	0.7810	-0.0723	-0.1257	-40	-340	0.9191	0.0003	-0.0909
-120	-60	0.7078	-0.0682	-0.1122	-40	-320	0.8954	-0.0004	-0.0921
-120	-40	0.6495	-0.0640	-0.1003	-40	-300	0.8730	0.0038	-0.0929
-100	-360	0.9182	-0.0144	-0.0886	-40	-280	0.8353	-0.0063	-0.1042
-100	-340	0.9288	-0.0074	-0.0895	-40	-260	0.7164	-0.0542	-0.1021
-100	-320	0.9252	-0.0084	-0.0931	-40	-240	0.5151	-0.0609	-0.0666
-100	-300	0.9234	-0.0098	-0.0980	-40	-220	0.3506	0.0121	-0.0180
-100	-280	0.9194	-0.0119	-0.1036	-40	-200	0.3946	0.0094	-0.0276
-100	-260	0.9175	-0.0131	-0.1112	-40	-180	0.4728	-0.0395	-0.0338
-100	-240	0.9119	-0.0158	-0.1201	-40	-160	0.5488	-0.0628	-0.0384

Table 4(a) Local Velocities at 0.25Dp behind the Propeller Plane without Propeller

y[mm]	z[mm]	u/U	v/U	w/U
-40	-140	0.6480	-0.0894	-0.0521
-40	-120	0.6985	-0.0959	-0.0725
-40	-100	0.7031	-0.0904	-0.0841
-40	-80	0.6907	-0.0901	-0.0889
-40	-60	0.6352	-0.0900	-0.0908
-40	-40	0.5509	-0.0709	-0.0969
-30	-200	0.3536	0.0461	0.0526
-30	-190	0.3886	0.0161	0.0394
-30	-180	0.4167	-0.0061	0.0323
-30	-170	0.4806	-0.0245	0.0343
-30	-160	0.5141	-0.0414	0.0252
-30	-150	0.5614	-0.0641	0.0205
-30	-140	0.5878	-0.0703	0.0020
-30	-130	0.6318	-0.0859	-0.0109
-30	-120	0.6373	-0.0875	-0.0210
-30	-110	0.6583	-0.0943	-0.0402
-30	-100	0.6481	-0.0886	-0.0520
-30	-90	0.6405	-0.0893	-0.0533
-20	-360	0.9171	-0.0021	-0.0899
-20	-340	0.9119	-0.0003	-0.0894
-20	-320	0.8831	0.0022	-0.0887
-20	-300	0.8499	0.0061	-0.0873
-20	-280	0.7591	-0.0116	-0.1067
-20	-260	0.5646	-0.0575	-0.1019
-20	-240	0.3631	-0.0319	-0.0819
-20	-220	0.2681	0.0334	-0.0445
-20	-200	0.3632	0.0587	0.1130
-20	-180	0.4432	0.0078	0.0968
-20	-160	0.5006	-0.0360	0.0854
-20	-140	0.5436	-0.0547	0.0635
-20	-120	0.5839	-0.0702	0.0315
-20	-100	0.5994	-0.0769	-0.0019
-20	-80	0.5830	-0.0737	-0.0360
-20	-60	0.5530	-0.0805	-0.0649
-20	-40	0.4825	-0.0639	-0.0862
-10	-200	0.4311	0.0080	0.1784
-10	-190	0.3924	0.0274	0.1530
-10	-180	0.4268	-0.0029	0.1573
-10	-170	0.4375	-0.0196	0.1544
-10	-160	0.4702	-0.0329	0.1483
-10	-150	0.4771	-0.0391	0.1390
-10	-140	0.4933	-0.0546	0.1238
-10	-130	0.5053	-0.0587	0.1005
-10	-120	0.5013	-0.0652	0.0834
-10	-110	0.5121	-0.0684	0.0644
-10	-100	0.5192	-0.0623	0.0487
-10	-90	0.5299	-0.0699	0.0139
0	-360	0.9143	-0.0003	-0.0884
0	-340	0.9074	0.0042	-0.0893
0	-320	0.8807	0.0030	-0.0862
0	-300	0.8435	0.0037	-0.0876
0	-280	0.6947	0.0151	-0.0989
0	-260	0.5397	0.0043	-0.1105
0	-240	0.4143	-0.0004	-0.1473
0	-220	0.2812	-0.0170	0.0778
0	-200	0.3950	0.0214	0.2312
0	-180	0.4238	0.0138	0.1778
0	-160	0.4437	0.0038	0.1686
0	-140	0.4566	0.0040	0.1342
0	-120	0.4639	0.0012	0.1093
0	-100	0.4600	-0.0036	0.0648
0	-80	0.4579	-0.0155	0.0202
0	-60	0.4431	-0.0194	-0.0306
0	-40	0.4046	-0.0142	-0.0744
10	-200	0.3555	-0.0086	0.1600
10	-190	0.3967	-0.0096	0.1449
10	-180	0.4183	0.0116	0.1488
10	-170	0.4466	0.0286	0.1517
10	-160	0.4552	0.0391	0.1465
10	-150	0.4796	0.0483	0.1334
10	-140	0.4882	0.0504	0.1177
10	-130	0.4888	0.0548	0.1035
10	-120	0.4995	0.0621	0.0849
10	-110	0.4918	0.0567	0.0668
10	-100	0.5057	0.0637	0.0495
10	-90	0.5127	0.0633	0.0268
20	-360	0.9170	0.0018	-0.0881
20	-320	0.8855	0.0028	-0.0876
20	-300	0.8502	0.0036	-0.0894
20	-280	0.7501	0.0392	-0.1035
20	-240	0.4019	0.0434	-0.0825
20	-220	0.3000	-0.0254	-0.0504
20	-200	0.3642	-0.0370	0.1000
20	-180	0.4287	0.0074	0.0835
20	-160	0.4960	0.0426	0.0850
20	-140	0.5533	0.0613	0.0652
20	-120	0.5640	0.0696	0.0371
20	-100	0.5940	0.0715	0.0031
20	-80	0.5752	0.0710	-0.0314
20	-60	0.5569	0.0750	-0.0625
20	-40	0.4594	0.0643	-0.0869
30	-200	0.3550	-0.0310	0.0361
30	-190	0.3822	-0.0066	0.0395
30	-180	0.4158	0.0258	0.0334
30	-170	0.4572	0.0398	0.0233
30	-160	0.5009	0.0595	0.0225
30	-150	0.5558	0.0723	0.0212
30	-140	0.5786	0.0763	0.0030
30	-130	0.6035	0.0830	-0.0054
30	-120	0.6095	0.0825	-0.0212
30	-110	0.6213	0.0778	-0.0304
30	-100	0.6261	0.0830	-0.0389
30	-90	0.6295	0.0803	-0.0490
40	-360	0.9179	0.0043	-0.0866
40	-340	0.9186	0.0080	-0.0889
40	-320	0.9018	0.0084	-0.0899
40	-300	0.8793	0.0045	-0.0937
40	-280	0.8421	0.0218	-0.1009
40	-260	0.7176	0.0733	-0.0932
40	-240	0.5332	0.0733	-0.0462
40	-220	0.3881	0.0090	-0.0170
40	-200	0.4096	0.0210	-0.0285
40	-180	0.4843	0.0419	-0.0293
40	-160	0.5678	0.0682	-0.0398
40	-140	0.6528	0.0881	-0.0512
40	-120	0.6658	0.0873	-0.0636
40	-100	0.6687	0.0871	-0.0756
40	-80	0.6611	0.0781	-0.0810
40	-60	0.6433	0.0895	-0.0920
40	-40	0.5280	0.0693	-0.0966
60	-360	0.9189	0.0079	-0.0866
60	-340	0.9224	0.0098	-0.0877
60	-320	0.9137	0.0102	-0.0909
60	-300	0.9018	0.0090	-0.0941
60	-280	0.8947	0.0138	-0.1001
60	-260	0.8517	0.0244	-0.1062
60	-240	0.7706	0.0518	-0.0984
60	-220	0.6718	0.0540	-0.0868
60	-200	0.6451	0.0632	-0.0980
60	-180	0.6911	0.0765	-0.1111
60	-160	0.7324	0.0882	-0.1183
60	-140	0.7589	0.0898	-0.1197

Table 4(a) Local Velocities at 0.25Dp behind the Propeller Plane without Propeller

y[mm]	z[mm]	u/U	v/U	w/U
60	-120	0.7652	0.0896	-0.1247
60	-100	0.7442	0.0845	-0.1168
60	-80	0.7159	0.0883	-0.1111
60	-60	0.6693	0.0829	-0.1086
60	-40	0.5778	0.0727	-0.0996
80	-360	0.9193	0.0103	-0.0868
80	-340	0.9235	0.0126	-0.0883
80	-320	0.9258	0.0110	-0.0924
80	-300	0.9202	0.0118	-0.0958
80	-280	0.9181	0.0131	-0.1003
80	-260	0.9042	0.0135	-0.1099
80	-240	0.8897	0.0123	-0.1229
80	-220	0.8715	0.0249	-0.1378
80	-200	0.8559	0.0405	-0.1527
80	-180	0.8420	0.0527	-0.1564
80	-160	0.8285	0.0647	-0.1536
80	-140	0.8281	0.0757	-0.1481
80	-120	0.8054	0.0791	-0.1417
80	-100	0.7855	0.0801	-0.1345
80	-80	0.7399	0.0818	-0.1232
80	-60	0.6896	0.0790	-0.1168
80	-40	0.6027	0.0699	-0.1010
100	-360	0.9207	0.0144	-0.0866
100	-340	0.9235	0.0152	-0.0882
100	-320	0.9240	0.0149	-0.0923
100	-300	0.9251	0.0144	-0.0968
100	-280	0.9209	0.0191	-0.1009
100	-260	0.9133	0.0177	-0.1092
100	-240	0.9136	0.0196	-0.1191
100	-220	0.9108	0.0246	-0.1307
100	-200	0.8992	0.0378	-0.1410
100	-180	0.8897	0.0444	-0.1500
100	-160	0.8763	0.0579	-0.1519
100	-140	0.8535	0.0648	-0.1473
100	-120	0.8276	0.0709	-0.1419
100	-100	0.8040	0.0727	-0.1343
100	-80	0.7496	0.0743	-0.1253
100	-60	0.6871	0.0723	-0.1138
100	-40	0.6186	0.0674	-0.0978
120	-360	0.9198	0.0169	-0.0858
120	-340	0.9242	0.0197	-0.0877
120	-320	0.9242	0.0201	-0.0914
120	-300	0.9253	0.0223	-0.0956
120	-280	0.9240	0.0244	-0.1012
120	-260	0.9136	0.0259	-0.1066
120	-240	0.9143	0.0299	-0.1140
120	-220	0.9095	0.0375	-0.1208
120	-200	0.9056	0.0443	-0.1283
120	-180	0.9012	0.0472	-0.1370
120	-160	0.8902	0.0567	-0.1402
120	-140	0.8690	0.0608	-0.1399
120	-120	0.8366	0.0633	-0.1354
120	-100	0.8032	0.0659	-0.1311
120	-80	0.7494	0.0679	-0.1198
120	-60	0.6935	0.0665	-0.1113
120	-40	0.6287	0.0683	-0.0943
140	-340	0.9259	0.0236	-0.0868
140	-320	0.9228	0.0253	-0.0903
140	-300	0.9271	0.0278	-0.0947
140	-280	0.9237	0.0304	-0.0989
140	-260	0.9148	0.0333	-0.1037
140	-240	0.9125	0.0366	-0.1096
140	-220	0.9110	0.0434	-0.1145
140	-200	0.9077	0.0504	-0.1199
140	-180	0.9030	0.0498	-0.1270
140	-160	0.8938	0.0563	-0.1298
140	-140	0.8700	0.0598	-0.1314
140	-120	0.8358	0.0605	-0.1267
140	-100	0.7964	0.0631	-0.1243
140	-80	0.7447	0.0626	-0.1139
140	-60	0.6937	0.0618	-0.1070
140	-40	0.6584	0.0674	-0.0983

Table 4(b) Local Velocities at 0.25Dp behind the Propeller Plane with Working Propeller

y[mm]	z[mm]	u/U	v/U	w/U	y[mm]	z[mm]	u/U	v/U	w/U
-180	-360	0.9345	-0.0411	-0.0970	-120	-60	0.7056	-0.0969	-0.0950
-180	-340	0.9224	-0.0444	-0.1006	-120	-40	0.6327	-0.0967	-0.0851
-180	-320	0.9259	-0.0499	-0.1040	-100	-360	0.9171	-0.0285	-0.1111
-180	-300	0.9236	-0.0547	-0.1071	-100	-340	0.9103	-0.0323	-0.1167
-180	-280	0.9202	-0.0611	-0.1101	-100	-320	0.9049	-0.0372	-0.1226
-180	-260	0.9186	-0.0646	-0.1131	-100	-300	0.8963	-0.0384	-0.1272
-180	-240	0.9136	-0.0739	-0.1150	-100	-280	0.8877	-0.0411	-0.1375
-180	-220	0.9149	-0.0807	-0.1166	-100	-260	1.0339	0.0159	-0.1860
-180	-200	0.9109	-0.0881	-0.1170	-100	-240	1.0378	-0.0428	-0.2196
-180	-180	0.9078	-0.0930	-0.1172	-100	-220	1.0406	-0.0744	-0.2296
-180	-160	0.9021	-0.0982	-0.1170	-100	-200	1.0232	-0.1085	-0.2315
-180	-140	0.8802	-0.0967	-0.1154	-100	-180	1.0089	-0.1268	-0.2194
-180	-120	0.8405	-0.0977	-0.1125	-100	-160	0.9810	-0.1319	-0.2012
-180	-100	0.8004	-0.0929	-0.1065	-100	-140	0.8740	-0.1310	-0.1391
-180	-80	0.7613	-0.0950	-0.1027	-100	-120	0.8231	-0.1241	-0.1189
-180	-60	0.7384	-0.0964	-0.0951	-100	-100	0.8170	-0.1184	-0.1113
-180	-40	0.7149	-0.1004	-0.0961	-100	-80	0.7449	-0.1099	-0.1025
-160	-360	0.9322	-0.0389	-0.1006	-100	-60	0.6940	-0.0997	-0.0932
-160	-340	0.9236	-0.0430	-0.1046	-100	-40	0.6098	-0.0949	-0.0846
-160	-320	0.9205	-0.0479	-0.1086	-80	-360	0.9154	-0.0232	-0.1148
-160	-300	0.9202	-0.0530	-0.1121	-80	-340	0.9064	-0.0275	-0.1193
-160	-280	0.9157	-0.0598	-0.1162	-80	-330	0.9059	-0.0286	-0.1210
-160	-260	0.9149	-0.0643	-0.1206	-80	-320	0.9050	-0.0288	-0.1238
-160	-240	0.9071	-0.0748	-0.1226	-80	-300	0.8909	-0.0235	-0.1310
-160	-220	0.9067	-0.0829	-0.1239	-80	-280	1.0500	0.0173	-0.1930
-160	-200	0.9031	-0.0913	-0.1243	-80	-260	1.0831	0.0096	-0.2339
-160	-180	0.9015	-0.0981	-0.1220	-80	-240	1.0829	-0.0228	-0.2708
-160	-160	0.8973	-0.1034	-0.1212	-80	-220	1.0667	-0.0705	-0.2826
-160	-140	0.8803	-0.1032	-0.1197	-80	-200	1.0458	-0.1201	-0.2841
-160	-120	0.8446	-0.1021	-0.1162	-80	-180	1.0335	-0.1563	-0.2596
-160	-100	0.8057	-0.0962	-0.1104	-80	-160	1.0271	-0.1729	-0.2303
-160	-80	0.7511	-0.0964	-0.1028	-80	-140	1.0157	-0.1661	-0.1943
-160	-60	0.7192	-0.0940	-0.0957	-80	-120	0.8154	-0.1364	-0.1722
-160	-40	0.6892	-0.0989	-0.0918	-80	-110	0.8047	-0.1261	-0.1084
-140	-360	0.9231	-0.0365	-0.1046	-80	-100	0.7934	-0.1220	-0.1016
-140	-340	0.9177	-0.0402	-0.1085	-80	-90	0.7676	-0.1201	-0.1002
-140	-320	0.9164	-0.0453	-0.1135	-80	-80	0.7223	-0.1133	-0.0945
-140	-300	0.9149	-0.0504	-0.1179	-80	-60	0.6791	-0.1028	-0.0867
-140	-280	0.9041	-0.0589	-0.1238	-80	-40	0.5806	-0.0927	-0.0807
-140	-260	0.9057	-0.0629	-0.1274	-60	-360	0.9120	-0.0189	-0.1162
-140	-240	0.8995	-0.0746	-0.1309	-60	-340	0.8998	-0.0225	-0.1202
-140	-220	0.8957	-0.0845	-0.1325	-60	-330	0.8992	-0.0226	-0.1214
-140	-200	0.8918	-0.0961	-0.1335	-60	-320	0.8953	-0.0199	-0.1253
-140	-180	0.8918	-0.1029	-0.1302	-60	-300	1.0485	0.0456	-0.1651
-140	-160	0.8902	-0.1101	-0.1268	-60	-280	1.0841	0.0683	-0.2196
-140	-140	0.8767	-0.1078	-0.1237	-60	-260	1.0929	0.0627	-0.2677
-140	-120	0.8429	-0.1082	-0.1190	-60	-240	1.0654	0.0179	-0.3193
-140	-100	0.8046	-0.0990	-0.1130	-60	-220	1.0302	-0.0612	-0.3381
-140	-80	0.7525	-0.1001	-0.1067	-60	-200	1.0010	-0.1383	-0.3314
-140	-60	0.7028	-0.0954	-0.0930	-60	-180	1.0017	-0.1885	-0.2917
-140	-40	0.6611	-0.0972	-0.0877	-60	-160	1.0186	-0.2084	-0.2461
-120	-360	0.9214	-0.0330	-0.1082	-60	-140	1.0442	-0.2047	-0.2039
-120	-340	0.9166	-0.0372	-0.1127	-60	-120	0.9809	-0.1980	-0.1731
-120	-320	0.9121	-0.0422	-0.1184	-60	-110	0.9128	-0.1641	-0.2106
-120	-300	0.9049	-0.0463	-0.1227	-60	-100	0.7619	-0.1253	-0.0938
-120	-280	0.8957	-0.0528	-0.1300	-60	-90	0.7334	-0.1218	-0.0876
-120	-260	0.8966	-0.0574	-0.1365	-60	-80	0.7020	-0.1176	-0.0843
-120	-240	0.8942	-0.0710	-0.1435	-60	-60	0.6569	-0.1067	-0.0790
-120	-220	0.8894	-0.0845	-0.1508	-60	-40	0.5421	-0.0906	-0.0781
-120	-200	0.8820	-0.1015	-0.1529	-40	-360	0.9112	-0.0120	-0.1185
-120	-180	0.8840	-0.1112	-0.1425	-40	-340	0.8986	-0.0160	-0.1220
-120	-160	0.8811	-0.1179	-0.1337	-40	-330	0.8911	-0.0145	-0.1219
-120	-140	0.8931	-0.1146	-0.1267	-40	-320	0.8830	0.0146	-0.1122
-120	-120	0.8403	-0.1159	-0.1212	-40	-300	1.0798	0.0863	-0.1770
-120	-100	0.8243	-0.1077	-0.1137	-40	-280	1.0975	0.1282	-0.2199
-120	-80	0.7488	-0.1041	-0.1053	-40	-260	1.0697	0.1437	-0.2802

Table 4(b) Local Velocities at 0.25Dp behind the Propeller Plane with Working Propeller

y [mm]	z [mm]	u/U	v/U	w/U
-40	-240	0.9825	0.0926	-0.3654
-40	-220	0.8620	-0.0829	-0.4018
-40	-200	0.7725	-0.1859	-0.3180
-40	-180	0.8529	-0.2329	-0.2684
-40	-160	0.9646	-0.2527	-0.2212
-40	-140	1.0468	-0.2425	-0.1779
-40	-120	1.0209	-0.2332	-0.1479
-40	-110	0.9937	-0.2132	-0.1323
-40	-100	0.8801	-0.1963	-0.2085
-40	-90	0.6840	-0.1131	-0.0645
-40	-80	0.6463	-0.1122	-0.0638
-40	-60	0.6109	-0.1019	-0.0661
-40	-40	0.4998	-0.0869	-0.0729
-20	-360	0.9123	-0.0049	-0.1203
-20	-340	0.8918	-0.0078	-0.1227
-20	-330	0.8818	-0.0053	-0.1218
-20	-320	1.0421	0.0975	-0.0629
-20	-300	1.1007	0.1208	-0.1617
-20	-280	1.1030	0.1766	-0.1925
-20	-260	1.0070	0.2338	-0.2421
-20	-240	0.8277	0.2557	-0.3605
-20	-180	0.6982	-0.2570	-0.1253
-20	-160	0.8970	-0.2782	-0.0910
-20	-140	1.0451	-0.2615	-0.0762
-20	-120	1.0477	-0.2505	-0.0706
-20	-110	1.0292	-0.2409	-0.0712
-20	-100	1.0164	-0.2524	-0.1153
-20	-90	0.6090	-0.0965	-0.0462
-20	-80	0.5683	-0.1061	-0.0278
-20	-60	0.5158	-0.0859	-0.0475
-20	-40	0.4142	-0.0645	-0.0839
0	-360	0.9120	0.0024	-0.1203
0	-340	0.8893	0.0005	-0.1245
0	-330	0.8802	0.0042	-0.1200
0	-320	1.0728	0.0917	-0.0838
0	-300	1.1055	0.1421	-0.1368
0	-280	1.1175	0.2009	-0.1436
0	-260	0.9815	0.3031	-0.1546
0	-240	0.6817	0.3925	-0.1290
0	-200	0.5597	-0.2735	0.3651
0	-180	0.7677	-0.2605	0.1706
0	-160	0.9403	-0.2831	0.1593
0	-140	1.0590	-0.2684	0.1376
0	-120	1.0444	-0.2484	0.1079
0	-110	1.0269	-0.2239	0.0725
0	-100	0.9623	-0.3243	-0.0830
0	-90	0.4087	-0.0700	0.0537
0	-80	0.3893	0.0001	0.0200
0	-60	0.3599	-0.0107	-0.0342
0	-40	0.3102	0.0060	-0.0888
20	-360	0.9087	0.0046	-0.1202
20	-340	0.8931	0.0114	-0.1243
20	-330	0.8836	0.0112	-0.1227
20	-320	1.0270	0.0822	-0.0292
20	-300	1.1063	0.1404	-0.1136
20	-280	1.1235	0.1968	-0.0978
20	-260	1.0555	0.2683	-0.0599
20	-240	0.7815	0.3561	0.0853
20	-220	0.6792	0.2929	0.4224
20	-200	0.8158	-0.0400	0.5436
20	-180	0.9128	-0.1843	0.4653
20	-160	0.9634	-0.2369	0.3830
20	-140	1.0731	-0.1865	0.2792
20	-120	1.0729	-0.1461	0.1725
20	-110	1.0375	-0.0920	0.1109
20	-100	1.0117	-0.1158	-0.0762

y [mm]	z [mm]	u/U	v/U	w/U
20	-90	0.5647	-0.0363	-0.0637
20	-80	0.5444	0.1108	-0.0452
20	-60	0.4861	0.0948	-0.0573
20	-40	0.4072	0.0698	-0.0814
40	-360	0.9112	0.0121	-0.1191
40	-340	0.8937	0.0176	-0.1228
40	-330	0.8896	0.0186	-0.1228
40	-320	0.8721	0.0257	-0.1078
40	-300	1.0963	0.1225	-0.0944
40	-280	1.1362	0.1726	-0.0663
40	-260	1.1364	0.2041	-0.0224
40	-240	1.0297	0.2333	0.0692
40	-220	0.8843	0.2226	0.2172
40	-200	0.8733	0.0790	0.3017
40	-180	0.9846	-0.0358	0.2752
40	-160	1.0680	-0.0962	0.2041
40	-140	1.1073	-0.0943	0.1240
40	-120	1.0897	-0.0648	0.0440
40	-110	1.0718	-0.0379	0.0174
40	-100	0.9085	-0.0870	-0.1609
40	-90	0.6594	0.1004	-0.0654
40	-80	0.6331	0.1166	-0.0750
40	-60	0.5740	0.1046	-0.0709
40	-40	0.4841	0.0792	-0.0777
60	-360	0.9102	0.0197	-0.1170
60	-340	0.9021	0.0234	-0.1218
60	-330	0.8992	0.0254	-0.1224
60	-320	0.8903	0.0259	-0.1247
60	-300	1.0705	0.0934	-0.0750
60	-280	1.1242	0.1374	-0.0593
60	-260	1.1658	0.1630	-0.0156
60	-240	1.1512	0.1563	0.0305
60	-220	1.1126	0.1260	0.0792
60	-200	1.1057	0.0710	0.1058
60	-180	1.1323	0.0122	0.1020
60	-160	1.1478	-0.0223	0.0621
60	-140	1.1388	-0.0325	0.0137
60	-120	1.0938	-0.0038	-0.0340
60	-110	1.0123	-0.0600	-0.1646
60	-100	0.7158	0.1049	-0.0961
60	-90	0.6978	0.1219	-0.0977
60	-80	0.6748	0.1149	-0.0914
60	-60	0.6136	0.1064	-0.0812
60	-40	0.5439	0.0920	-0.0795
70	-240	1.1709	0.1367	0.0208
70	-180	1.1690	0.0247	0.0508
80	-360	0.9158	0.0253	-0.1145
80	-340	0.9042	0.0301	-0.1193
80	-330	0.9045	0.0297	-0.1212
80	-320	0.8944	0.0313	-0.1237
80	-300	0.8845	0.0354	-0.1233
80	-280	1.0751	0.0963	-0.0664
80	-260	1.1313	0.1207	-0.0344
80	-240	1.1676	0.1185	-0.0003
80	-220	1.1678	0.0962	0.0240
80	-200	1.1714	0.0624	0.0373
80	-180	1.1747	0.0307	0.0198
80	-160	1.1583	0.0117	-0.0092
80	-140	1.1150	0.0155	-0.0494
80	-120	0.7943	0.0501	-0.1437
80	-110	0.7602	0.1151	-0.1168
80	-100	0.7464	0.1174	-0.1146
80	-90	0.7344	0.1129	-0.1093
80	-80	0.7157	0.1142	-0.1047
80	-60	0.6437	0.1076	-0.0918
80	-40	0.5768	0.0948	-0.0829

Table 4(b) Local Velocities at 0.25Dp behind the Propeller Plane with Working Propeller

y[mm]	z[mm]	u/U	v/U	w/U
90	-240	1.1421	0.1051	-0.0194
90	-180	1.1708	0.0428	-0.0099
100	-360	0.9163	0.0312	-0.1105
100	-340	0.9107	0.0345	-0.1162
100	-330	0.9128	0.0370	-0.1177
100	-320	0.9015	0.0397	-0.1204
100	-300	0.8922	0.0419	-0.1239
100	-280	0.8820	0.0494	-0.1226
100	-260	1.0817	0.0053	-0.0201
100	-240	1.1024	0.0860	-0.0479
100	-220	1.1191	0.0811	-0.0305
100	-200	1.1231	0.0657	-0.0252
100	-180	1.1177	0.0515	-0.0413
100	-160	1.1074	0.0167	-0.0743
100	-140	0.8271	0.0900	-0.1316
100	-120	0.7970	0.1125	-0.1276
100	-110	0.7822	0.1106	-0.1190
100	-100	0.7661	0.1094	-0.1170
100	-90	0.7385	0.1052	-0.1052
100	-80	0.7200	0.1034	-0.1040
100	-60	0.6480	0.0964	-0.0897
100	-40	0.6036	0.0910	-0.0828
110	-320	0.9090	0.0419	-0.1184
110	-300	0.9023	0.0453	-0.1228
110	-280	0.8903	0.0498	-0.1257
110	-260	0.8879	0.0561	-0.1249
110	-240	0.9408	-0.0274	-0.0454
110	-220	1.1055	0.0389	-0.0517
110	-200	1.1051	0.0414	-0.0576
110	-180	1.0791	-0.0398	-0.0885
110	-160	0.8596	0.0791	-0.1301
110	-140	0.8400	0.1028	-0.1346
120	-360	0.9216	0.0348	-0.1069
120	-340	0.9142	0.0398	-0.1115
120	-330	0.9147	0.0421	-0.1130
120	-320	0.9099	0.0437	-0.1167
120	-300	0.9002	0.0466	-0.1207
120	-280	0.8877	0.0561	-0.1206
120	-260	0.8807	0.0624	-0.1232
120	-240	0.8783	0.0677	-0.1260
120	-220	0.8752	0.0705	-0.1255
120	-200	0.8754	0.0752	-0.1268
120	-180	0.8666	0.0879	-0.1316
120	-160	0.8609	0.0976	-0.1314
120	-140	0.8469	0.1045	-0.1284
120	-120	0.8150	0.1044	-0.1218
120	-100	0.7775	0.1019	-0.1121
120	-80	0.7302	0.0992	-0.1060
120	-60	0.6730	0.0942	-0.0950
120	-40	0.6276	0.0929	-0.0839
130	-240	0.8873	0.0685	-0.1255
130	-180	0.8762	0.0916	-0.1257
140	-360	0.9308	0.0363	-0.1035
140	-340	0.9257	0.0408	-0.1075
140	-320	0.9187	0.0464	-0.1116
140	-300	0.9147	0.0524	-0.1149
140	-280	0.9049	0.0589	-0.1176
140	-260	0.9001	0.0648	-0.1205
140	-240	0.8925	0.0700	-0.1233
140	-220	0.8920	0.0773	-0.1242
140	-200	0.8819	0.0866	-0.1256
140	-180	0.8823	0.0940	-0.1255
140	-160	0.8771	0.0996	-0.1255
140	-140	0.8569	0.1001	-0.1240
140	-120	0.8266	0.1002	-0.1202
140	-100	0.7830	0.0970	-0.1135
140	-80	0.7276	0.0935	-0.1027
140	-60	0.6848	0.0933	-0.0949
140	-40	0.6558	0.0910	-0.0879

SRI M. S. No. 631

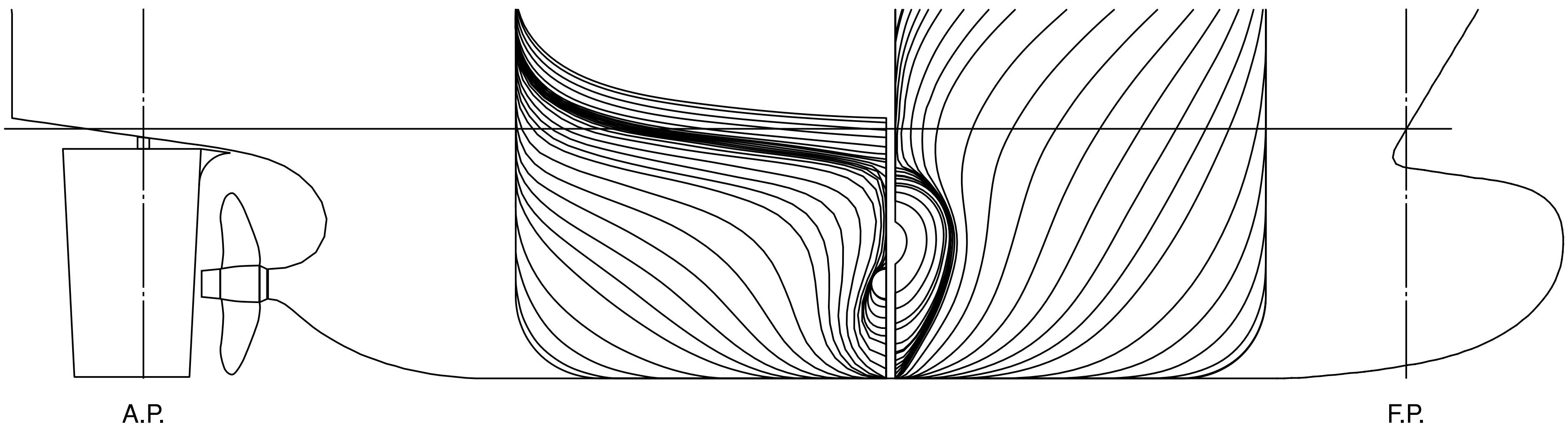


Fig. 1 Body Plan and Side Profile of Ship Model, SRI M. S. No. 631

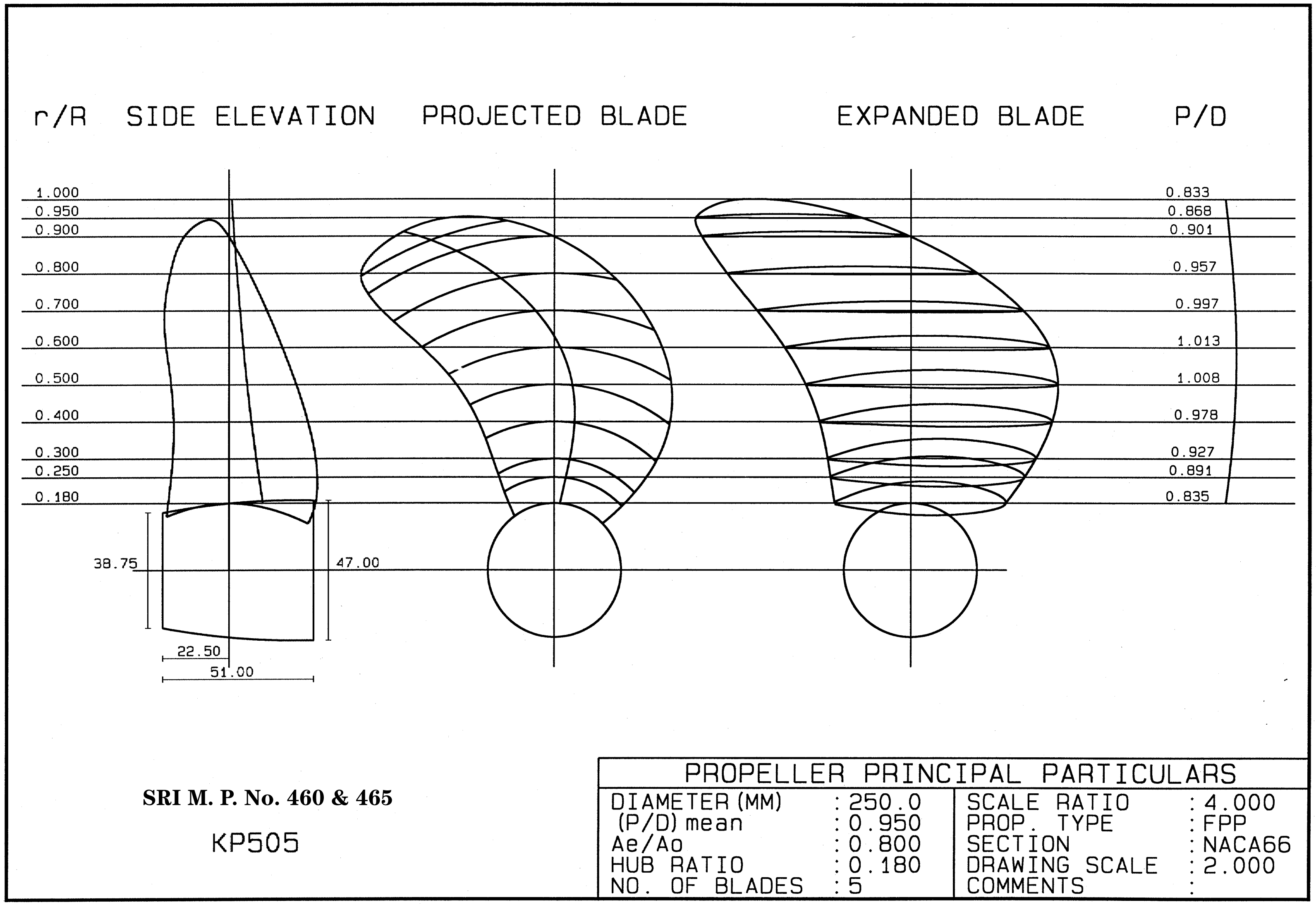


Fig. 2 Geometrical Shape Model of Propeller, SRI M. P. No. 460 & 465

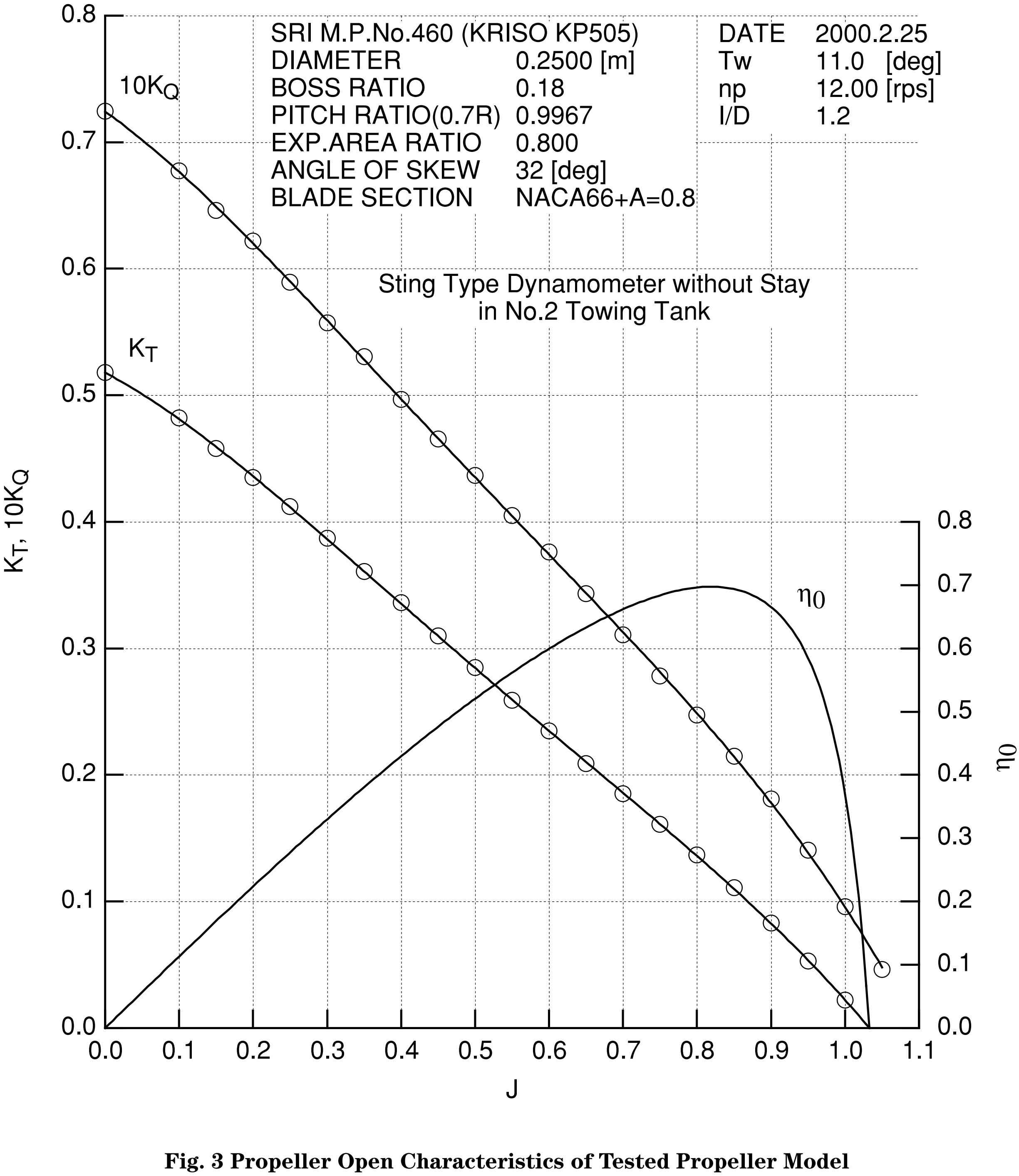
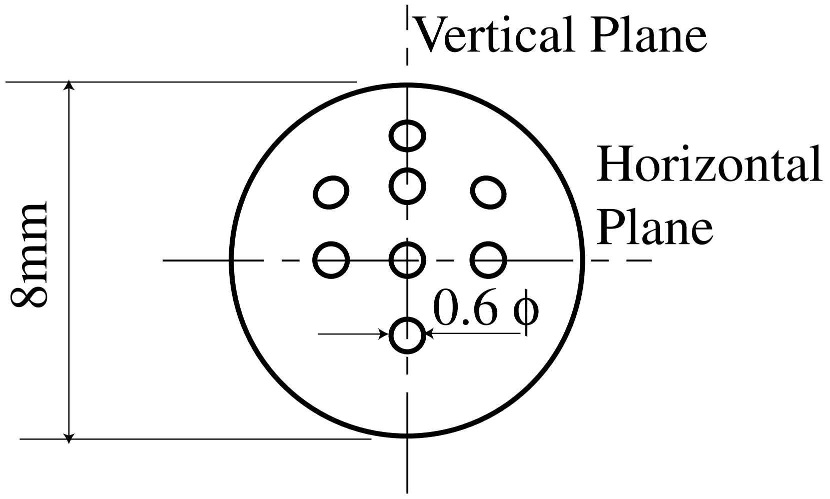
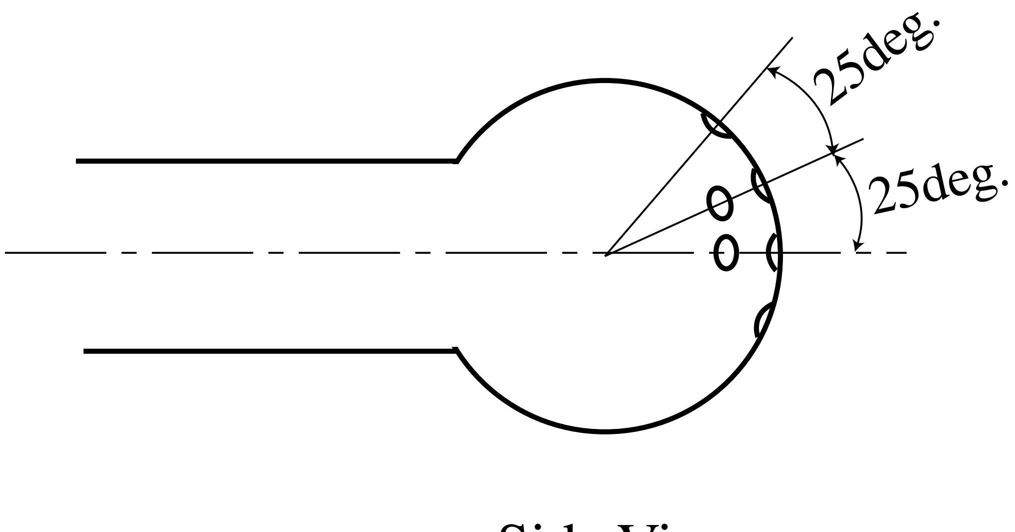


Fig. 3 Propeller Open Characteristics of Tested Propeller Model

8-Hole Pitot Tube

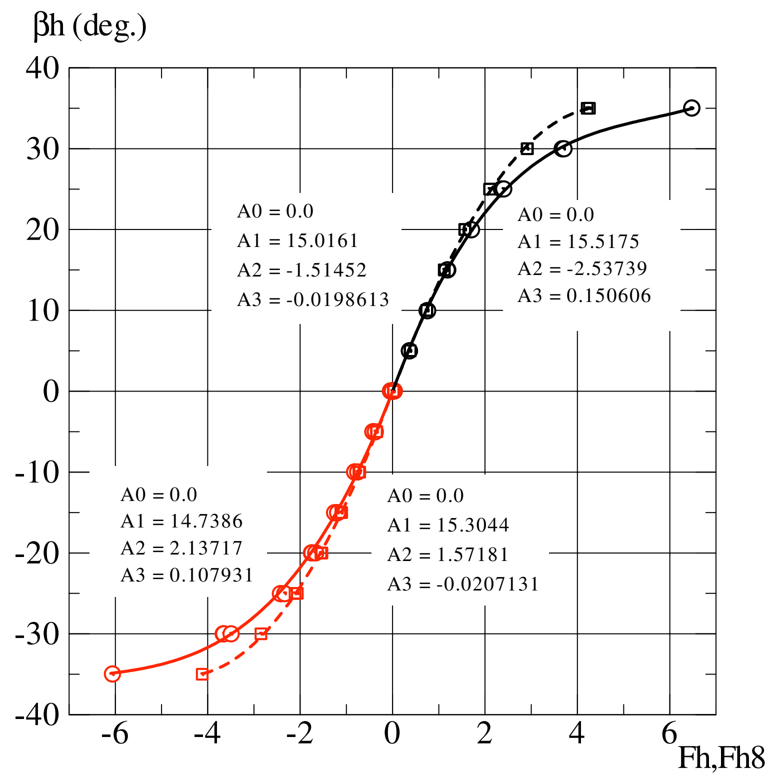


Front View

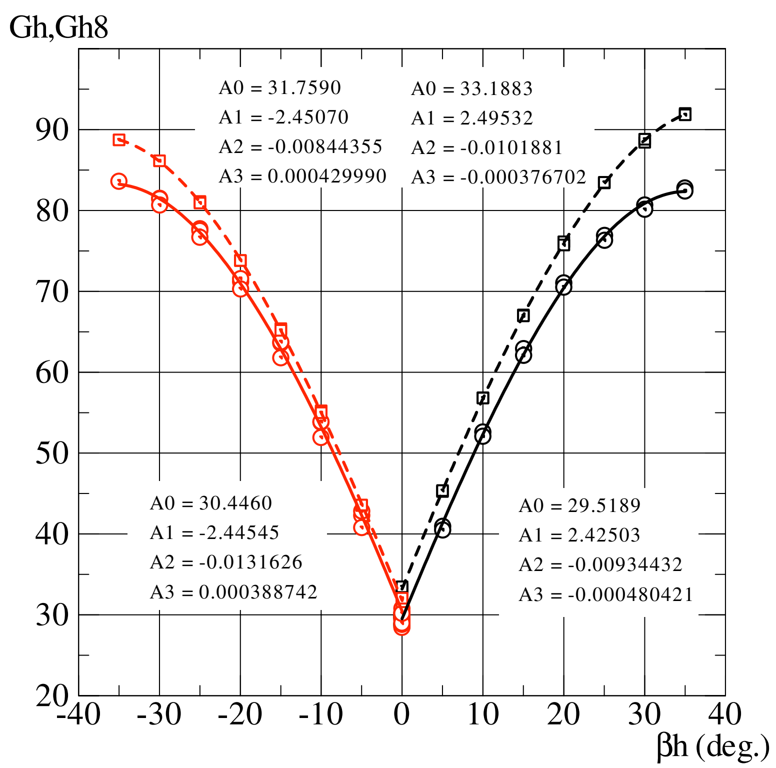


Side View

Fig. 4 Geometrical Shape of Eight-Hole Pitot Tube

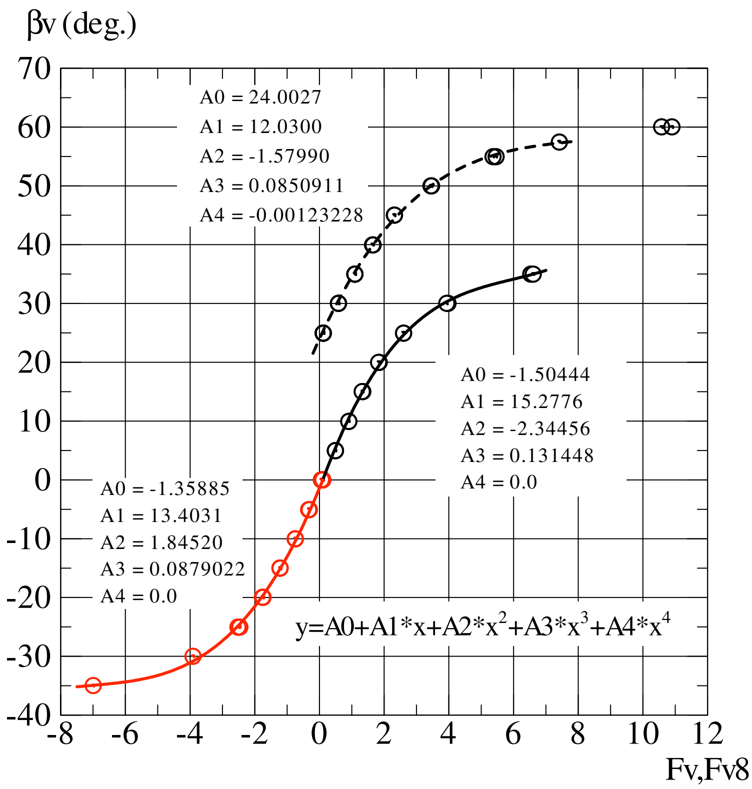


(a) Correlation Curves of Horizontal Flow Angle βh versus Fh and Fh8

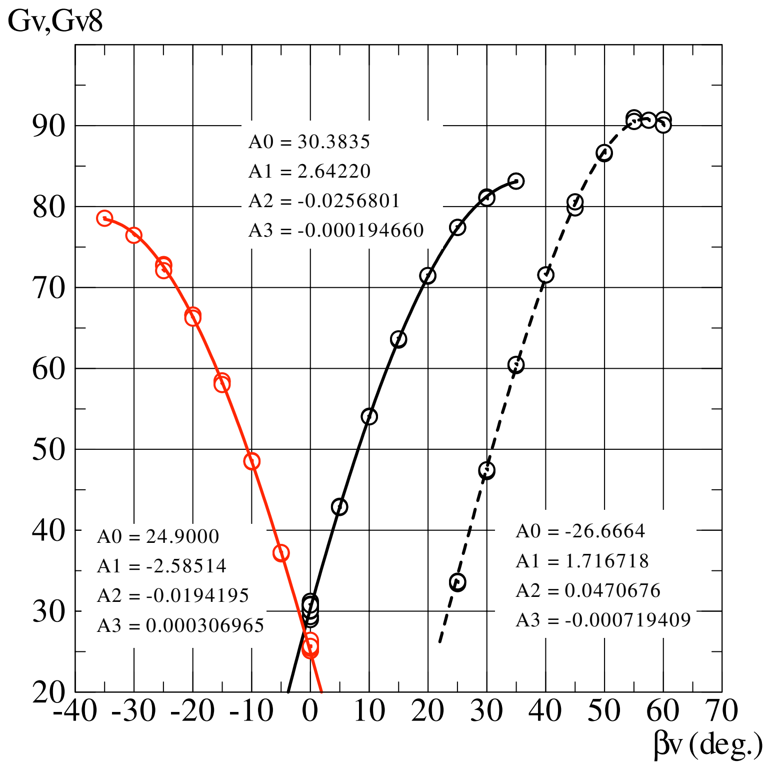


(b) Correlation Curves of Gh and Gh8 versus Horizontal Flow Angle βh

Fig. 5 Calibration Curves of Eight-Hole Pitot Tube



(c) Correlation Curves of Vertical Flow Angle βv versus Fv and Fv8



(d) Correlation Curves of Gv and Gv8 versus Vertical Flow Angle βv

Fig. 5 Calibration Curves of Eight-Hole Pitot Tube

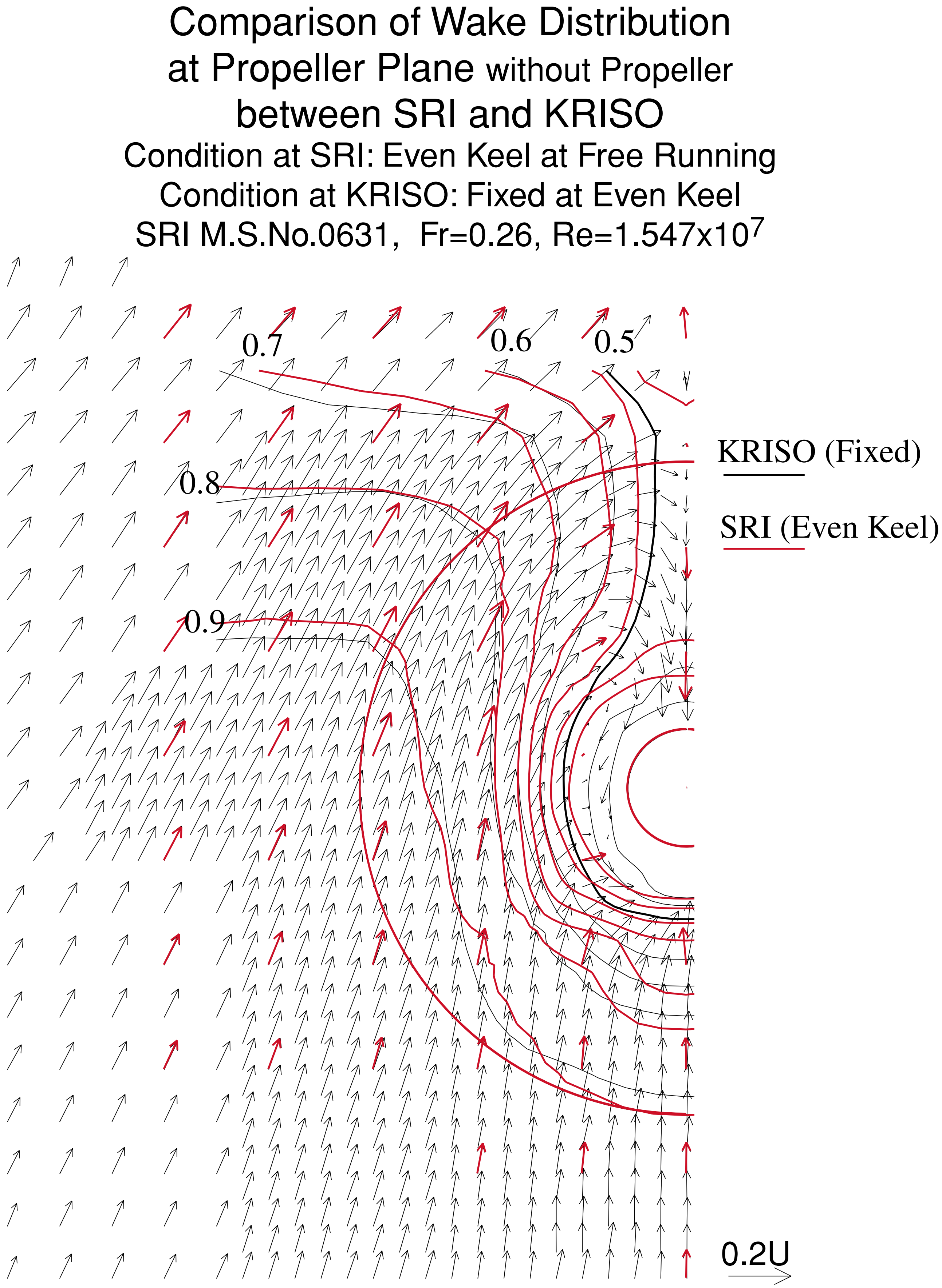


Fig. 6 Comparison of Local Velocity Field Measurements in the Propeller Plane between SRI and KRISO

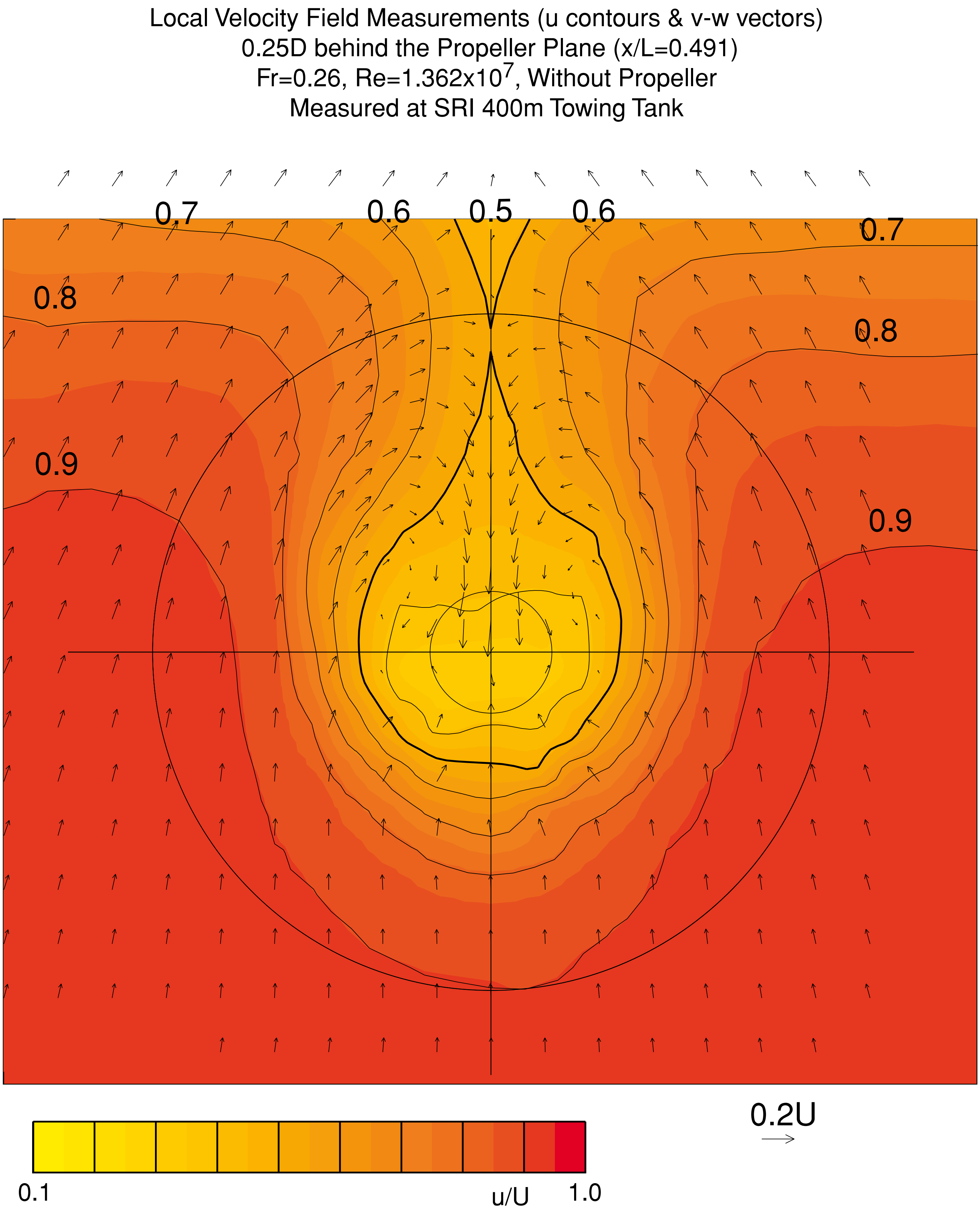


Fig. 7 Measured Results of Local Velocity Field at 0.25D behind the Propeller Plane without Propeller

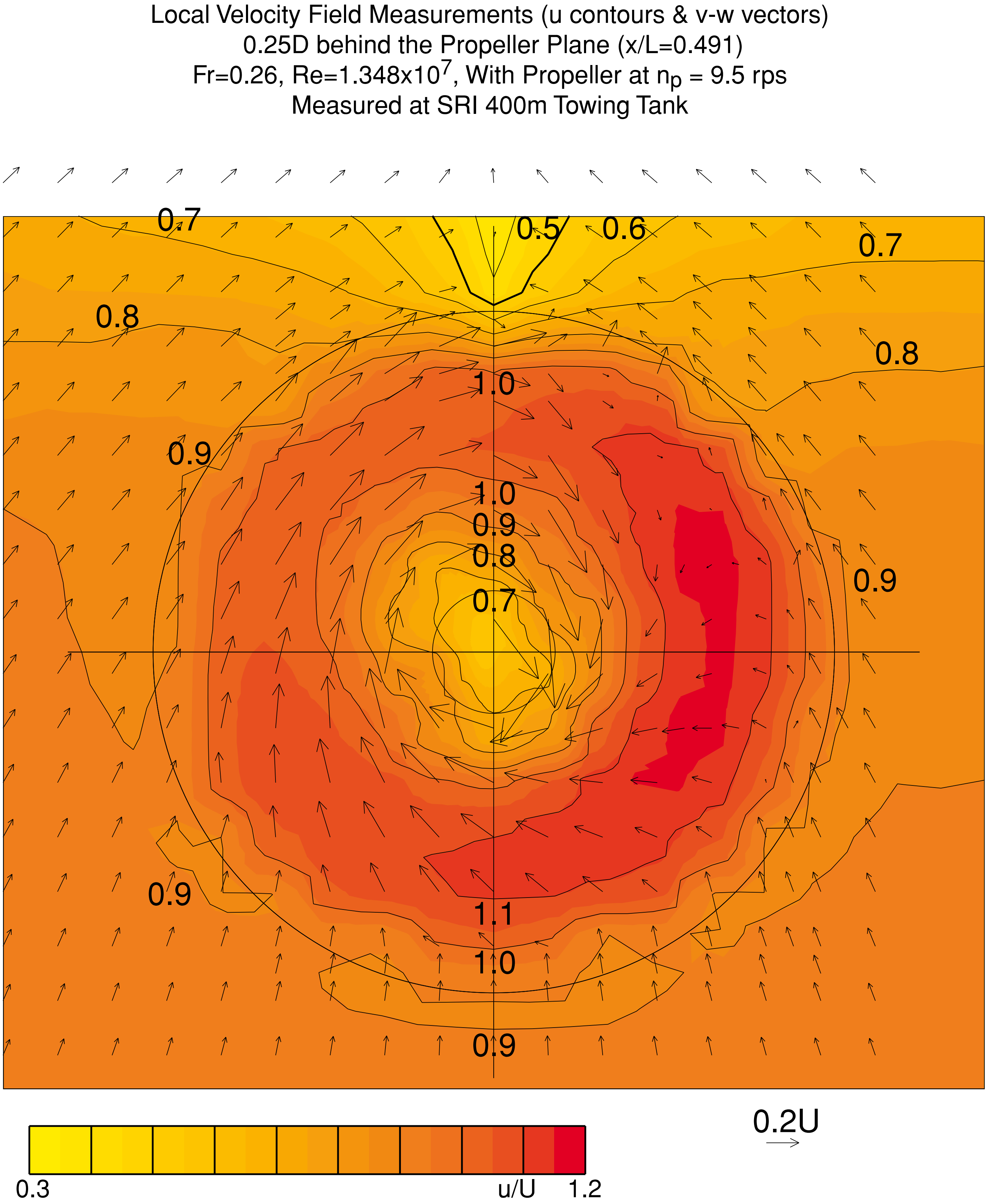


Fig. 8 Measured Results of Local Velocity Field at 0.25D behind the Propeller Plane with the Working Propeller