SESSION ON NEW FACILITIES

Chairman: R. Adm. P. O'Dogherty

According to the Recommendations of the 16th Conference a Group Discussion on new hydrodynamic test facilities and new instrumentation systems and techniques should be organized by the 17th ITTC Information Committee. It was subsequently decided to arrange a separate Session on New Facilities and to focus the Group Discussions on a number of specific topics. (See next Chapter.) In the invitation to the Conference the Delegates and Observers were therefore also invited to forward material on new facilities or systems incorporating new designs or ideas within the field of "tankery". The material presented has here been arranged in three Sections, covering New Model Test Facilities, Extensions or Modifications to Existing Facilities, and Instrumentation and Measuring Techniques respectively. The discussion was not documented.

I. NEW MODEL TEST FACILITIES

E. ENKVIST - Wärtsilä Arctic Research Centre, Wärtsilä Helsinki Shipyard, Helsinki, Finland.

DESCRIPTION OF THE NEW ICE MODEL BASIN AT WARC

General

In January 1981 Wärtsilä decided to replace the old ice model test facility, constructed in cooperation with Esso International in 1969 and used by Wärtsilä's Helsinki Shipyard since that.

In February 1983 WARC and its new facility was inaugurated and since that it has been run according to a tight schedule with 4 icesheets a week. The main customers are Wärtsilä's Shipyards, but some 20% of the capacity may be used for outside clients.

Model testing in ice is a relatively young technology. Two conditions must be fulfilled:

- A substantial full-scale backing must exist. With some 50 cases of field tests with ships of different size and type Wärtsilä possesses this background and it is constantly improved.

- A suitable model ice material must be used in order to obtain geometric, kinematic and dynamic similarity To this end WARC developed a novel model ice material, Ref. [1].

The facility has been mainly used for ship model testing, but also tests with offshore structures have been made.

Facility

Main Particulars

Building:	Volume	18800 m^3
Test Basin:	Total length	77.3 m
	Test sheet	60.0 m
	Width	6.5 m
	Water depth	2.3 m
	Minimum temperature	-37°C
	Ice thickness	10-80 mm
Observation windows:	At bottom	10
	At sides	16
Carriages:	Test carriage	
	- weight	32 t
	- speed	0-3 m/s
	Second carriage	
	- weight	25 t
	speed	0-1.5 m/s

Additional Details

The main basin is a concrete structure. Its large side- and bottom-windows are extremely important for visual observations of ice interaction phenomena.

The carriages are driven by racks and pinions on both rails and the control system enables steady creeping speeds down to a few millimetres per second, which is important for offshore structure testing.

The second carriage is used for testing the mechanical properties of the model ice as well as skimming of the ice sheet after testing.

There is a modular platform enabling shallow-water testing.

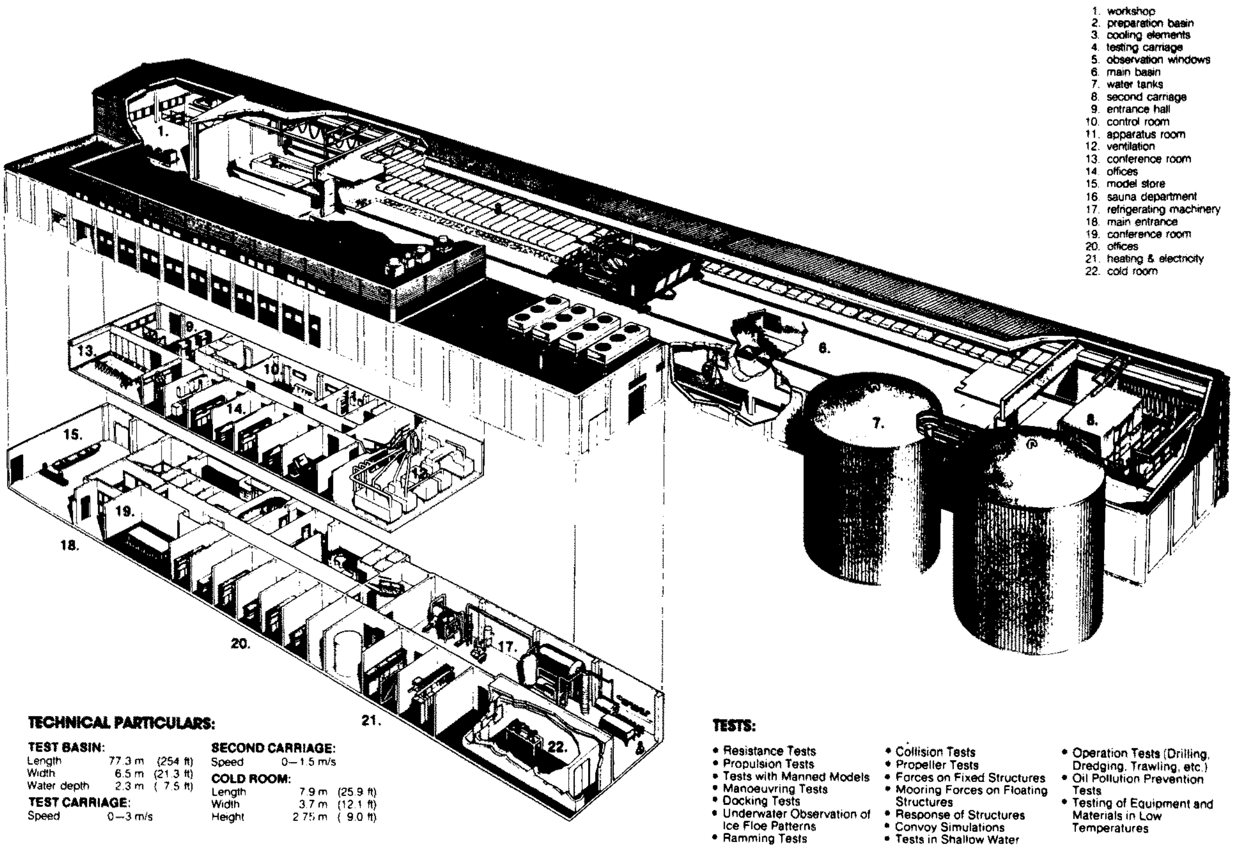
All test recording is made in the heated control space of the towing carriage. After the test the tapes are digitized and analysed in the office.

The ship tests are made both as constant speed towing tests and as towed propulsion tests. The offshore structure tests are made both as towing tests and by means of pushing the ice sheet against a stationary structure.

The freezing plant includes a single screw compressor of 200 kW and a Freon 22 system with ceiling coolers of natural convection type with ample headroom to provide uniform ice.

The ice is skimmed into a melting tank and the salt water is reused. Currently a 2% saline solution is employed.

Testing is made both in level ice and rubble fields. The snow cover is not simulated.



WÄRTSILÄ ARCTIC RESEARCH CENTRE

The main concern of the staff is the improving of the full scale correlation, model ice control, interpreting propulsion test results and correct modeling of mechanical friction.

Reference

[1] Enkvist, E., and Mäkinen, S.: "Experience with a New Type of Model Ice". SNAME, ICETECH -84.

K.-H. MORI - Department of Naval Architecture & Ocean Engineering, Hiroshima University, Hiroshima, Japan.

THE TOWING TANK AND CIRCULATING WATER CHANNEL OF HIROSHIMA UNIVERSITY

Both facilities are newly constructed in connection with the move of the Department to the new campus in March 1982.

Towing Tank

The principal dimensions of the towing tank is shown in Fig. 1. The tank width is 10 m on the trimming tank side over a length of 20 m.

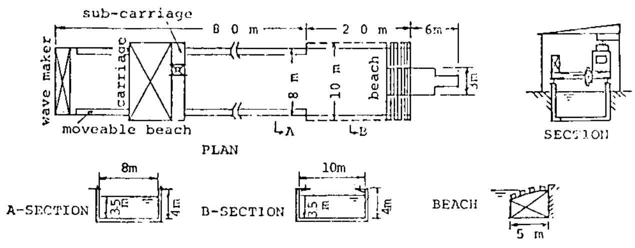


Fig 1 Towing Tank

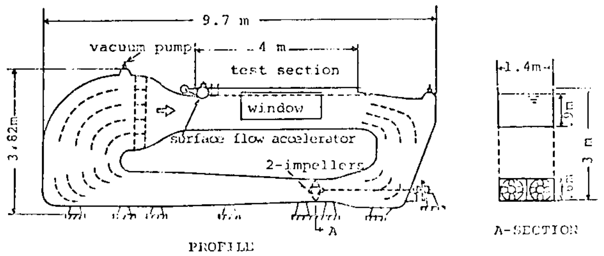


Fig 2 Water Circulating Channel

The tank has a plunger-type wave-maker which can generate both regular and irregular waves of 0.4~2.0 m in length and 0.05~0.4 m in height. Concrete-made flat plates are put on steel pillars to realize a rigid shallow bottom within ±1 mm accuracy in the water depth.

The maximum controllable carriage speed is 3.0 m/sec and the accelerating-decelerating rate is variable for 0.01~0.08 g. A computer-controlled sub-carriage is fitted on the main carriage for transverse and rotational motions.

Circulating Water Channel

The circulating water channel is of the vertical and open recirculating type with a twin-impeller system and a surface flow accelerator. Principal dimensions are shown in Fig. 2.

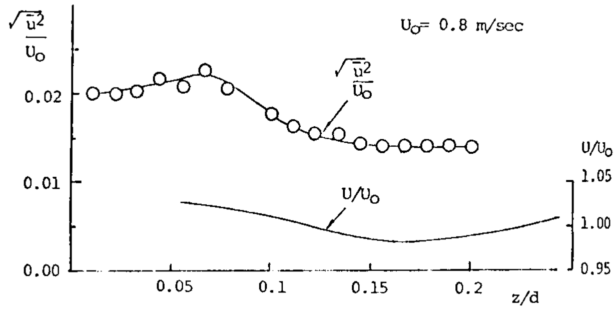


Fig 3a Mean Velocity and Turbulent Intencity Distributions in Vertical Direction (x/L = 0.5, y/b = 0.0)

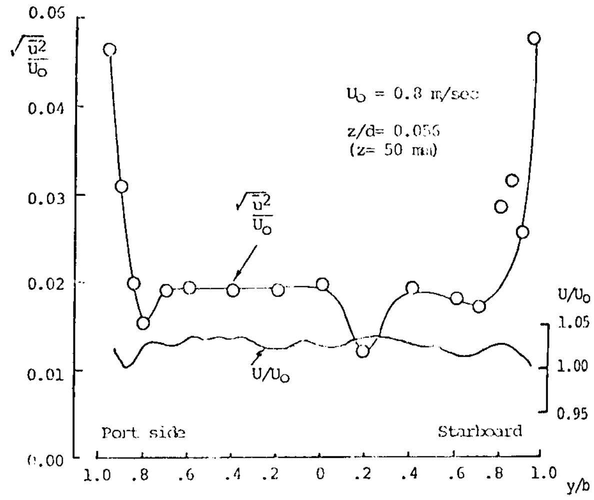


Fig 3b Mean Velocity and Turbulent Intencity Distribution in Lateral Direction (x/L = 0.5, z/d = 0.056)

It is intended to realize a uniform flow with low turbulence. Fig. 3 shows the mean velocity, U, and the turbulent intensities, $\sqrt{\overline{u^2}}$, both related to U_0, the standard velocity measured by a pitot-tube. x, y and z are the streamwise, transverse and vertical directions respectively, the origin is at the surface flow accelerator and the centerplane of the channel on the still water. L is length of the test section (4.0 m), b half breadth of the channel (0.7 m), d water depth (0.9 m). The uniformity of the mean velocity is within 2%, while the turbulent intensity is about 2% in the vicinity of the free-surface and less elsewhere, except near the wall where it is much greater.

F.-S. CHEN and L.-Q. YEH - Shanghai Ship & Shipping Research Institute, Shanghai, China.

BRIEF DESCRIPTION OF THE CIRCULATING WATER CHANNEL AT SSSRI

1. Introduction

A suggestion for building a circulating water channel of medium size had been approved in 1979, and then the design and fabricating works started. It had been located and assembled in the Bensongyuan Road Branch Laboratory. At the beginning of 1983, it was shifted to the headquarter of SSSRI. The re-assembling and adjusting works had been finished in September 1983.

2. Main Particulars of the Channel

a. Type: Horizontal circuit with open sections except that for impeller.

b. Overall dimension:

Length	15.2 m
Breadth	4.8 m
Height	2.1 m

c. Dimension of working section:

Length	6.0 m
Breadth	1.5 m
Max. water depth	1.0 m

d. Dimension of converging section:

Length	2.0 m
Converging ratio	2.32

Equation of contour according to that given for cavitation tunnel by SRI Japan:

$$\left(\frac{r_1}{r}\right)^4 - 1 = \frac{1}{2\pi}\left\{\left(\frac{r_1}{r_0}\right)^4 - 1\right\}\left(\frac{2\pi x}{\ell} - \sin\frac{2\pi x}{\ell}\right)$$

where

r_0 = radius of outlet

r_1 = radius of inlet

r = radius of the section at x from inlet

ℓ = length of converging section

e. Impeller:

Diameter	0.98 m
No of blade	4
Blade area ratio	0.50
Tip pitch ratio	0.776
Mean pitch ratio	0.76
Rake angle	0 deg.
Drive mode	belt

f. Water speed 0.2 - 1.6 m/s

g. Ordinary model size 2.0 - 2.5 m in length

h. Power of driving motor 75 kW at 1500 rpm (actual need about 20 kW)

i. General arrangement ; shown in Fig. 1.

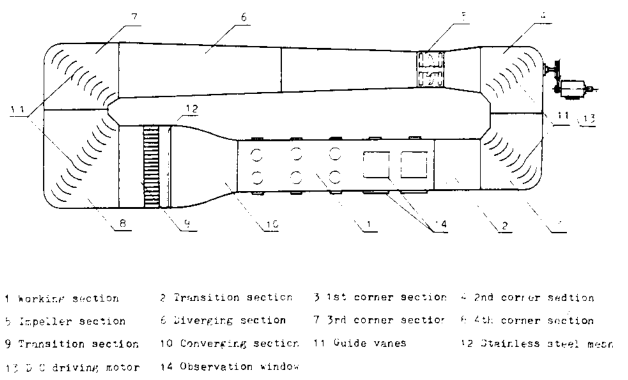


Fig 1 Sketch of the arrangement of the channel

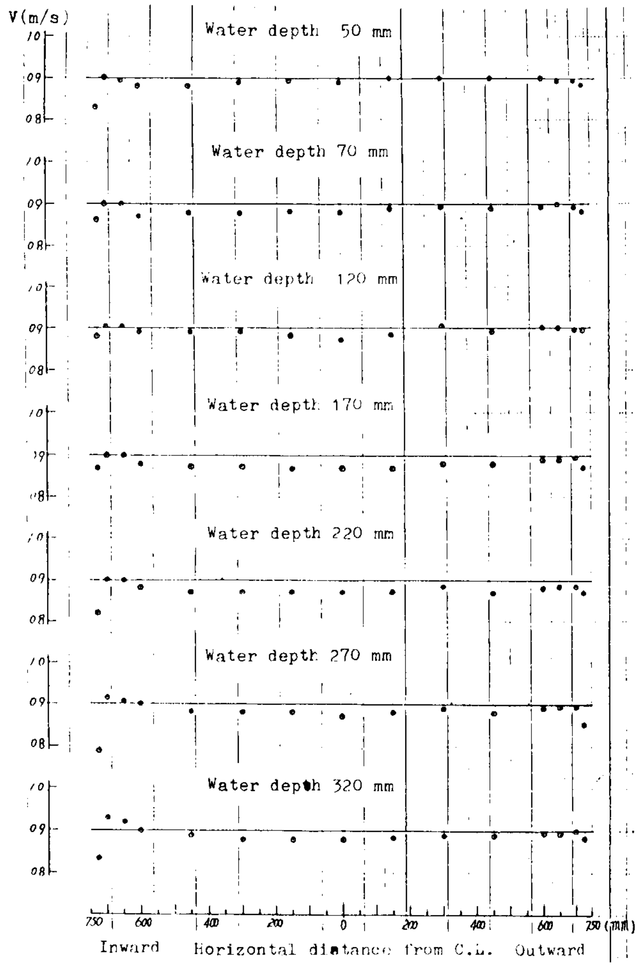


Fig 2 Water velocity distribution over the section 1.0 M from the outlet of the converging section at water velocity V = 0.914 m/s

3. Characteristics of the Channel

3.1. Un-evenness of water velocity distribution

At a number of sections and for several nominal speeds the water velocities were measured with pitot tubes at different depths and different distances from the centre line of the working section; the results are examplified in Fig. 2. The un-evenness of the velocity distribution for the nominal speed of 0.914 m/sec has been summarized in Table 1.

Table 1. Un-evenness of water velocity (for V = 0.914 m/s)

Location of section, m from the outlet of converging section	Un-evenness
1.0	-1.92 -- +2.37 %
1.4	-1.35 -- +2.32 %
1.8	-2.00 -- +2.22 %
3.0	-2.15 -- +2.26 %
4.0	-1.88 -- +1.99 %
5.0	-1.89 -- +2.50 %

3.2. Steadiness of water speed

The water speed was repeatedly measured with pitot tubes at 1.8 m from the outlet of converging section for 3 hours at an interval of 5 minutes. The result shows the unsteadiness of water speed is lower than 0.8 % as shown in Fig. 3.

3.3 Deviation of flow direction

Measurements with 5-hole pitot tube were made, and the result shows the deviation of flow direction to be within ±1° from C.L.

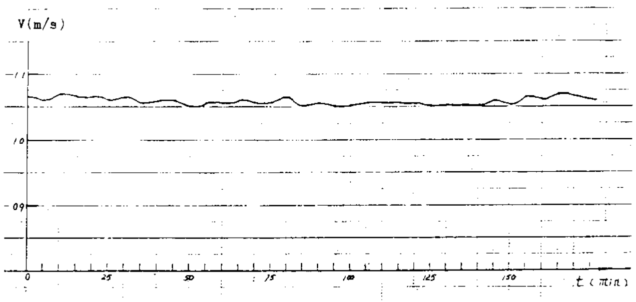


Fig 3 Water velocity variation with time

Table 2.

Water velocity (m/s)	Wave height (mm)	Slope of water surface tan θ
0.80	1.0	0.2×10^{-3}
0.914	1.5	0.53×10^{-3}
1.01	2.4	1.03×10^{-3}
1.205	5.8	1.066×10^{-3}

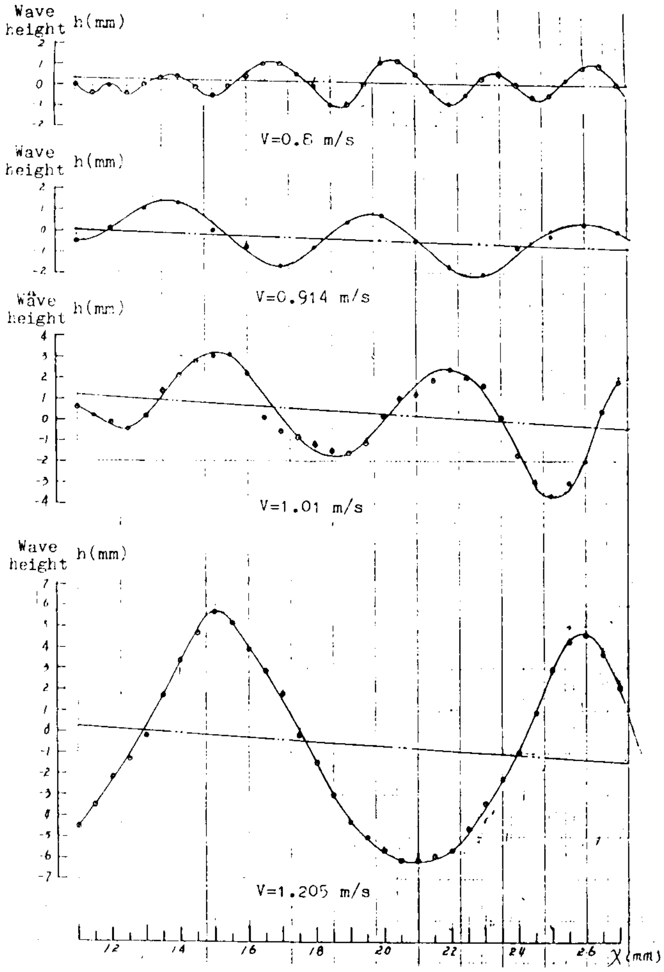


Fig 4 Wave height measured in working section

3.4. Wave height and slope of free water surface

The wave height and slope of free water surface at various water speed were measured with capacitance type wave probe from 1.0 m abaft the outlet of converging section at an interval of 10 cm. The results are shown in Fig. 4 and Table 2.

The wave height can be summarized as

$$h = 2.6 V^4$$

just to be the half of the value from the experience of most of Japanese channels.

3.5. Thickness of free surface boundary layer

It can be seen from Fig. 2 that the free surface boundary layer is about 3-5 mm.

A. G. BOVIS, J. C. DERN and J. L. GIOVACHINI -
Bassin d'Essais des Carênes, Paris, France

THE FUTURE LARGE HYDRODYNAMIC TUNNEL (GTH) OF BASSIN D'ESSAIS DES CARENES

1. Introduction

Many countries have been developing new test and research facilities during recent years with a view to solving increasingly acute problems facing naval architects in connection with the following :

a/ improvement of propulsive efficiency, more economical use of energy, reduction of vibration in merchant ships,

b/ acoustic discretion and "operability" of naval systems, new high-speed propulsion and sustention systems for warships.

In order to meet the present and future requirements of naval hydrodynamics, the French Navy has approved the construction of a new large Hydrodynamic Tunnel (Grand Tunnel Hydrodynamique) on behalf of the Bassin d'Essais des Carênes.

Alsthom Atlantique - Neyrtec is in charge of the design and construction of this new facility. The works starting at the end of 1983 must be completed at the end of 1986.

2. Applications of the "Large Hydrodynamic Tunnel

The G.T.H. project will be expected to provide naval architects with suitable solutions for most of their problems now and during the next decades as regards more efficient propulsion, reduced ship's screw vibration and noise, and more generally, widening of present marine system operating limits set by various flow conditions, e.g. vibrating appendages, flow induced sonar noise, flow separation and cavitation on rudders and stabilizers etc...

In addition to investigation of these problems further research will be required on unconventional sustentation and propulsion systems, especially if involving ventilation. In all the above, closer consideration of interaction between the hull, appendages and propulsion unit than is possible by present means will be essential. Hence, facilities will be required for testing complete ship models under conditions (dimensions, Reynolds number, cavitation similitude, acoustic deconfinement, vibration insulation etc...) allowing closer determination of appropriate full-scale extrapolation laws.

The new facility is bound to be extensively used for many different studies on various subjects as follows :

a/ Surface ships :
- wake studies,
- hull propeller-rudder interactions,
- propeller hull-appendage interaction and cavitation,
- propeller noise,
- bulb design,
- flow visualization.

b/ Submarines and underwater vehicles :
- wake studies at high Reynolds number,
- performance of advanced propulsors,
- hull propulsion - interaction
- cavitation and acoustic properties of propeller and appendage
- low drag vehicles.

c/ High speed unconventional ships :
- performance of ventilated propellers,
- unconventional propulsors : waterjet two-phase propulsor,
- hydrofoil design and performance,
- sustention of surface effect ships.

d/ Miscellaneous :
- performance of positioning systems for floating structures,
- high Reynolds flow studies,

- boundary layer control,
- cavitation erosion,
- flow induced vibrations on elastic structures,
- aerodynamics of ship superstructures at high Reynolds Number.

According to the preceding requirements the GTH was designed in order to test either with a free surface or in closed channel conditions :

- complete ships models, with propulsor and appendage,
- full-scale hull parts or torpedoes.

The achieved speeds allow to reach high Reynolds numbers or correct Froude conditions required as well for submerged bodies as for fast surface ships.

Better results will be expected especially for :

- flow quality,
- noise quality,
- cavitation conditions control.

3. <u>Overall characteristics of the large hydrodynamic tunnel</u>

a/ Main features of the GTH

Overall length : 73 m

Overall height : 16 m

Pumping power : main pump : 1.200 kW
auxiliary free surface pump 320 kW.

Two test sections are permanently installed :

• HSCTS : High Speed Closed Test Section,
- cross section 1.14 m x 1.14 m
- length : 6 m
- max. rated speed : 20 m/s
- max. flow rate : 25 m^3/s

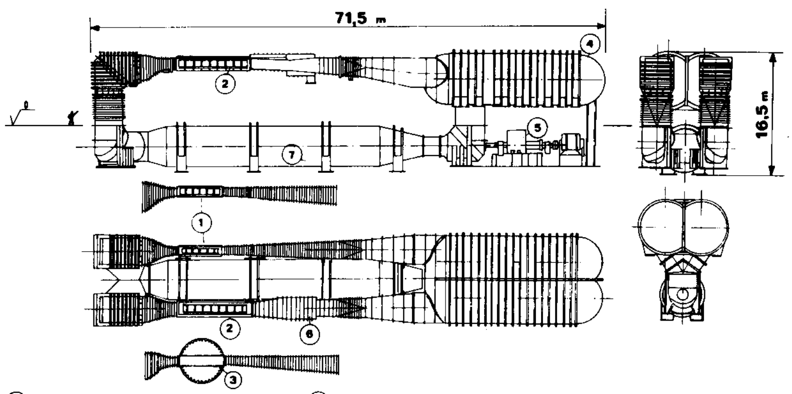
• FSTS : Free Surface Test Section
- cross section : 2 m x 1.35 m
- length : 10 m
- max. rated speed : 12 m/s
- max. flow rate : 32 m^3/s

FSTS can be used as well as an open channel test section as a closed circuit one. The two sections are parallel and can be used alternatively.

b/ Cavitation condition control

Pressure in test sections is adjustable from saturated water pressure up to 5 bar for HSCTS and 2 bar for FSTS (absolute).

GRAND TUNNEL HYDRODYNAMIQUE



(1) HSCTS 1.14 x 1.14 x 6 m
(2) FSTS 2.x 1.35 x 10 m
(3) Acoustic test section
(4) Deaerating tank
(5) Machinery Room
(6) Free Surface skimmer
(7) Resorber

BASSIN D'ESSAIS DES CARENES
PROJET NEYRTEC

Air content control is based on
- a large bubble deaerator located downstream of the test section,
- a large section resorber, located at the bottom part of the tank,
- a specially designed system to adjust the cavitation nuclei content to the required value by injection of vapor microbubbles upstream the test section.

c/ Special devices
- Free surface recirculation system, in order to limit the power requirements of the main pump,
- Elastic mounting of the tunnel and its equipments in order to prevent noise transmission,
- Sound isolated machinery room for all rotating machinery,
- Extensive use of stainless steel and corrosion resistant materials for limiting maintenance problems.
- Large dimension windows with low deflection to allow flow pattern observation and laser velocimetry.

4. Test models and instrumentation

Models to be tested can be submerged bodies or torpedoes which could be up to 5 m long and 0.50 m in diameter or surface ship models up to 8 m long, 1 m wide and featuring a maximum draught of 0.5 m.

The models are attached to the test section covers which integrate the test instrumentation.

Test instrumentation will include :
- high power propeller drive system for propeller diameters up to 0.50 m,
- vertical and lateral balances,
- vertical planar motion mechanism,
- 3-D laser velocimetry,
- hydrophone arrays in a specially designed acoustic section,
- high speed cinematography,
- 6-component dynamometers and pressure sensors,
- measurement devices for cavitation nuclei content.

Reference

BOVIS, A., VISCONTI, M.: "Le futur Grand Tunnel Hydrodynamique du Bassin d'Essais des Carênes". Association Technique Maritime et Aéronautique, 1984

II. EXTENSIONS OR MODIFICATIONS TO EXISTING FACILITIES

TZ. TZVETANOV, Y. YOVEV and L. BEKYAROV - BSHC, Varna, Bulgaria.

THE BSHC HIGH-SPEED TOWING CARRIAGE

1. Introduction

A new experimental facility for high-speed tests was put into operation at BSHC - Varna in 1983.

The concept for creation of the facility is based on the idea to use the BSHC deep water tank for high-speed tests. This is economically more efficient, because it

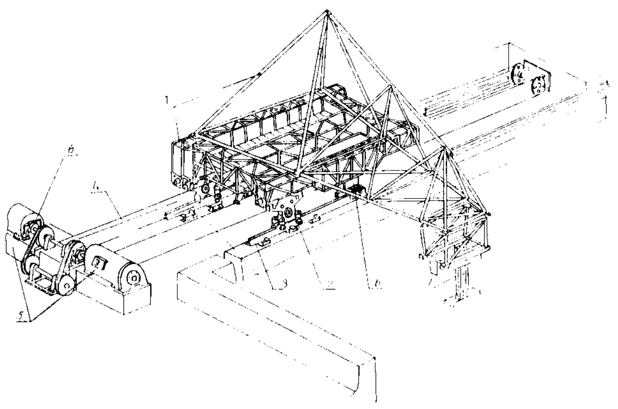


Fig 1 General view of a console type high-speed towing carriage

makes unnecessary the creation of a special high-speed tank whose cost would be too great.

At BSHC the problem was solved by a high-speed towing carriage of console type, mounted on one side of the tank and driven by an endless rope. The carriage ensures complete independence of the tests and the use of automated system for computer acquisition and processing of the data.

2. Structure of the high-speed towing carriage

The structural peculiarities of the carriage and its location in the deep water tank are shown on the axonometric sketch in Fig. 1.

The high-speed towing carriage is a non-motorized structure driven by a towing system with an endless rope and automatic speed control.

The carriage's major elements are (Fig. 1):
1 - metal structure
2 - wheel frame
3 - rails
4 - towing rope drive
5 - electric drive
6 - braking systems
7 - measuring device

The facility's operation is the following: After positioning the measuring device with the ship model, prepared for the tests, on the measuring frame, the carriage is driven automatically at a prescribed speed by the electric motors and the rope; the necessary information is registered by the transducers of the measuring device and is transmitted to the computer by a cable telemetry system.

3. Electric drive and automatic speed control system (ASCS)

The electric drive consists of two D.C. motors type D-818, 180 kW each. The rope system's driving drums are mounted on their shafts. The motors are fed by a Ward - Leonard group.

ASCS performs automatic control of the electric drive and consists of:

- controllable three-phase thyristor reversive rectifier for feeding the generator's exciting coil and respective control system
- semi-controllable two-phase thyristor rectifier for control of both motors' exciting coils, connected in series, and a respective control circuit
- relay circuit for performing the necessary logical operations for choice of the direction of motion, automatic starting and stopping of

the carriage, resetting of the speed, etc.

- control panel on the tank board

4. Measuring system

For carrying out model tests with the high-speed carriage, an automatic measuring system with separately located (on the carriage and on the land) elements with telemetry connection is built. The data acquisition and processing is performed by a computer PDP 11/10. The system's structure diagram is shown in Fig. 2, where

1 - measuring wheel with an incremental encoder for measurement of the carriage speed

2 - strain gauge transducer for measurement of the rope's strain

3 - strain gauge transducer for measurement of the model resistance

4 - transducer for the trim

5 - transducer for the sinkage

6, 7, 8, 9 - equipment for initial processing of transducer signals

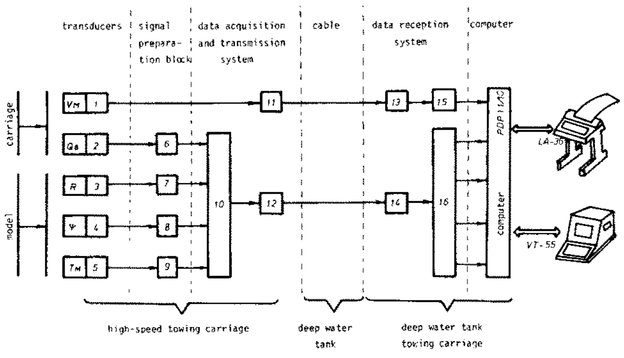


Fig 2

10, 11, 12, 13, 14, 15, 16 - telemetry system for acquisition and transmission of the data by a cable to the computer PDP 11/10

5. Major technical data

5.1. High-speed towing carriage:

- total weight - 3.5 t
- drive - by rope, from two D.C. motors, with automatic speed control,
- continuous strain of the rope is ensured
- speed - up to 20 m/s, accuracy ±0.1%.

5.2. Measuring system:

- power supply - cable 220 V, accumulator 24 V
- separately located elements with telemetry connection to the land by cable
- data processing by a computer PDP 11/10

5.2.1. Device for measurement of:

- resistance up to 350 N, trim $\pm 15^{o}$, sinkage ±350 mm
- measurement accuracy up to 1%

5.2.2 Multi-component dynamometer for foils:

- number of measured components - 6
- change of the angle of attack (-10^{o} - $+20^{o}$)
- measured forces - lifting force up to 2000 N, resistance up to 800 N, moments up to 300 Nm

J. C. DERN, J. L. GIOVACHINI and J. P. VARNIER -
Bassin d'Essais des Carenes, Paris, France

THE NEW SUBMERGED TOWING CARRIAGE AT PARIS MODEL BASIN

1. Introduction

Till last year, experiments in Bassin d'Essais des Carènes on submerged bodies towed by submarines (buoys, towed arrays etc...) were performed in a circulating water channel with a 1m × 1m working section allowing only the use of small models and flow velocities not above 2m/s.

To overcome these drawbacks, a submerged carriage has been designed, built and installed on the bottom of towing tank n° 3. The large cross section of this channel (13m × 4,5m) allows one to test fully submerged large scale models up to 5m long without significant bottom or wall effects. Other applications of this new facilities are listed below.

2. Description and Characteristics of the Facility

The towing system consists of a rigid flat steel "catamaran" structure that rides on steel wheels over a pair of ground stiff steel rails, so that a high natural vibration frequency, necessary for measurements, is obtained.

Speed is adjusted and maintained by two linear induction motors (U shape secondary type), the stators of which are mounted on each side of the carriage and feeded by a classical three phase trolley captation system picking up the current on lines lying along the rails in the channel water. Fig. 1 gives a schematic diagram of the towing carriage.

As far as an accurate speed control is required, a feedback control system is then used to increase the performance of the motors. The conventionnal feedback systems are not satisfactory in this application where very high speed regulation and fast dynamic response are required.

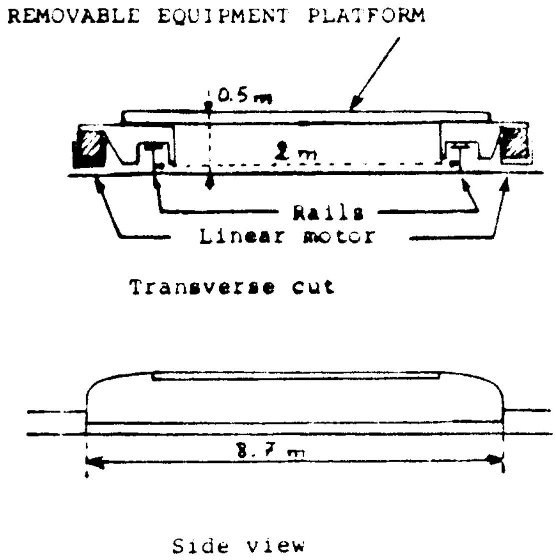


Fig 1 Schematic diagram of the towing carriage

A feedback system, based on an imposed stator current regulation gives good performance characteristics and is described in the bloc diagram in figure 2.

Electrical braking is provided to the carriage.

Measurements of all essential physical data : forces, speed accelerations, pressures,.. on test are obtained by electronic instrumentation.

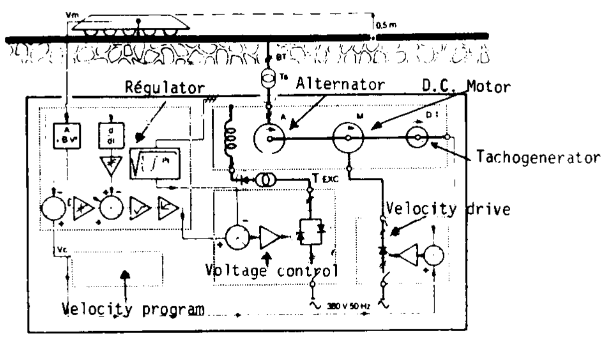


Fig 2 Bloc diagram of control system

A control station, located on the side of the tank, ensures all recording data by a cable link connected with the carriage and dragged in the water, during tests.

The main characteristics of the facility are :

a/ Rail Track :

length : 175m - accuracy 0,2mm/7m.
width : 2m

b/ Towing carriage :

length : 8,7m - removal platform 7m $\times$ 2,25m
width : 2,25m
height : 0,50m
weigth (with equipment) : 8 000 kg
natural frequency : 90 hz
speed : 0 to 5m/s
speed variation : $\pm 1^{\circ}/_{\circ\circ}$ of mean
accelerations controlled from 0 to $1 m/s^2$.

c/ Propulsion :

2 Linear induction motors :

- dimension : 108 $\times$ 230 $\times$ 4 800mm (14 poles)
- weight : 700 kg
- thrust : 10 000 N(for 5 A/mm^2)
- voltage : 0 - 55 V allowing captation in water
- current : 0 - 600 A
- time constant of all power system : 100 ms (up to 5 Hz excitations)

3. First Tests Performed with the Submerged Carriage

As an example of the usefullness of the submerged carriage we describe briefly the first tests that have been performed with it.

The goal of these tests was to study the behaviour of several designs of buoys towed by a submarine by means of a cable.

This cable is bound to the submerged carriage through a dynamometer to measure the cable tension. Other measured parameters were the inclination of the cable at its connection point with the submerged carriage, and the pitch angle of the buoy model.

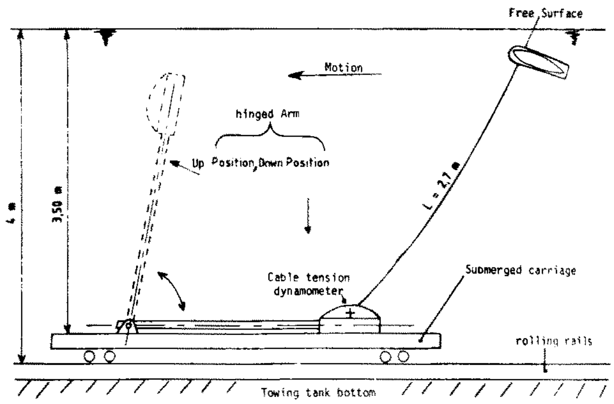


Fig 3 Principle of the experimental test configuration

The experimental set up is shown in figure 3. It can be noted the use of an hinged arm for an easy access to the buoy model.

The stability characteristics and the general behaviour of the towed buoys have been determined in better conditions than before :

- use of larger model of buoys and greater length of cable
- perfect smoothness and regularity of the incoming flow
- the effect of the free surface on the behaviour of the towed buoys is taken into account

This series of tests will be followed by tests of buoys in waves thus allowing for the first time to study the effects of waves on the behaviour of submerged bodies towed at large speeds.

4. Applications of the Submerged Carriage

The new facility is expected to be used for many different studies on the following subjects :

- towed bodies tests (buoys, arrays) in calm water and in waves

- study of flow around submerged bodies (visual observations or laser velocimetry)
- simulation of air flow at high Reynolds number (flow over ship superstructures, e.g)
- translation of ships or offshore structures models in order to simulate current
- measurement of hydrodynamic forces on submarines or any other submerged bodies.
- any other tests performed with the simultaneous use of the (aerial) carriage of the tank n° 3 and the submerged carriage.

K. YOSIFOV and R. KALCHEV - BSHC, Varna, Bulgaria.

ADDITIONAL TEST SECTION FOR THE BSHC CAVITATION TUNNEL

1. Introduction

In the standard measuring section (of the so-called "screw" type) of the BSHC cavitation tunnel tests of screw propeller models with up to 300 mm diameter are carried out. The maximum flow velocity in this case ensures, on the one hand, a minimum cavitation number equal to 0.2, and makes possible, on the other, the carrying out of fundamental hydrodynamic tests for investigation of the flow around hydrofoils, rudders and other submerged bodies.

Due to the limited dimensions of the measuring section the modelling of the wake distribution, for carrying out cavitation tests of screw propellers for particular ships, is realized with the aid of wire mesh stimulators. As it is well known, by means of such kind of stimulators only the axial wake component is modelled, which gives the predominating flow non-uniformity but does not duplicate the actual situation, in particular not for full ships.

The modern theoretical and applied ship hydrodynamics poses a broad range of new problems, which can be solved in an additional (exchangeable) measuring section with the proper dimensions and configuration.

2. Additional Test Section

The additional test section for the BSHC cavitation tunnel is an exchangeable one. It includes a closed-type measuring section with non-symmetric nozzles in front of and behind it (Fig. 1), having the following basic characteristics:

- cross-section - 1.45 x 0.70 m, length 6.00 m
- maximum flow velocity - 5.0 m/sec
- pressure adjustment in the upper part of the measuring section (the place of the ship model's load waterline) from 7 kPa

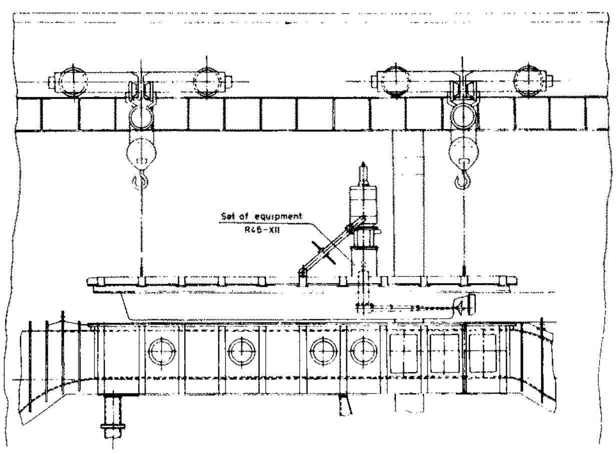


Fig 1

(0.07 kp/cm^2) to 200 kPa (2 kp/cm^2) absolute pressure

- non-symmetric (contraction only vertical from bottom to top) nozzle in front of the measuring section with contraction ratio 2.06 : 1

- non-symmetric (contraction in horizontal and expansion in vertical direction) nozzle (intermediate part) between the measuring section and the elbow behind it with resulting contraction ratio 1.21 : 1.

The dimensions of this measuring section allow the mounting of a whole or a slightly truncated ship model with length up to 5.0 m, width 0.7 ÷ 0.8 m and height (draught) 0.4 m, which make possible the carrying out of cavitation tests on screw propellers in a velocity field with three-dimensional non-uniformity and investigations, under these conditions, of cavitation processes, of hydrodynamic interaction between a cavitating propeller, ship hull and rudder, of pressure fluctuations on the hull surface, of thrust and torque periodic components, and of acoustic characteristics.

The test section forms one complete *unit with the nozzles in front of* and behind the measuring section, which has a special cover over its full length. To this cover the ship model, cut along the main waterline (Fig. 1), is attached. Openings are envisaged in the cover for mounting a specially developed set of equipment R46-XII (Fig. 2) for screw propeller driving and the thrust and torque measurements.

Unlike the designer's standard construction (Kempf and Remmers, Hamburg, FRG) large rectangular windows are envisaged in the last three spacings of the measuring section (on both sides and bottom). These windows are located in the model's screw propeller and rudder region and ensure better observance of cavitation processes, as well as the possibility for measuring the wake characteristics with the aid of a laser anemometer.

3. Set of Equipment for Screw Propeller Tests

The R46-XII set of equipment is developed by the firm "Kempf & Remmers" specially for use during screw propeller tests in a large measuring section and is mounted in the ship model. Unlike the standard design, a device is develop-

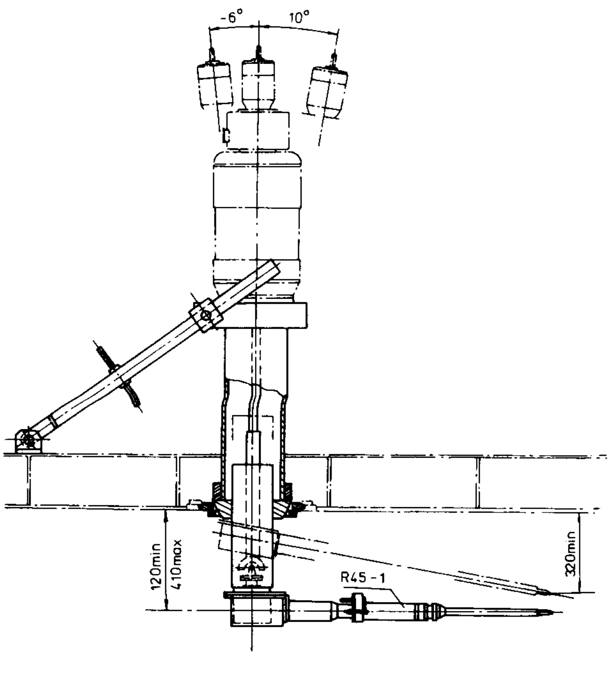


Fig 2

ed at BSHC for shaftline inclination angle (up to 16^{o}) for carrying out tests in oblique flow (for comparatively small and fast vessel models).

A watertight propeller dynamometer K & R R45 is used in this set of equipment. It has the following basic characteristics:

- number of revolutions - up to 50 rps
- thrust - up to ± 400 N
- torque - up to ± 15 Nm

III. INSTRUMENTATION AND MEASURING TECHNIQUES

ST. GORANOV, ST. STEPHANOV and
G. ZLATANOV - BSHC, Varna, Bulgaria.

TECHNICAL DESCRIPTION OF A SYSTEM FOR CONTROLLABLE PITCH SCREW PROPELLER TESTS WITH A DEVICE FOR MEASURING THE TORQUE MEAN VALUE AT THE BASE OF ONE OF THE BLADES

General

The functional scheme of the BSHC system for controllable pitch screw propeller model tests is presented in Fig. 1.

The system is constructed on the basis of a dynamometer for testing screw propeller models in open water, K & R type H39, manufactured by Kempf and Remmers, FRG, and the electronic devices connected to it.

A special device is developed, which is installed on the propeller end of the H39 shaft and serves for measuring the torque mean value at the base of the screw propeller blade.

The principle scheme of the device, illustrating its structure and operation, is shown in Fig. 2, while Fig. 3 is a photo of the device with dismantled fairwater.

The basic constructional part of the device is the special hub, in the bulk of which a measuring element with strain gauges and blade-mounting devices are arranged, allowing smooth

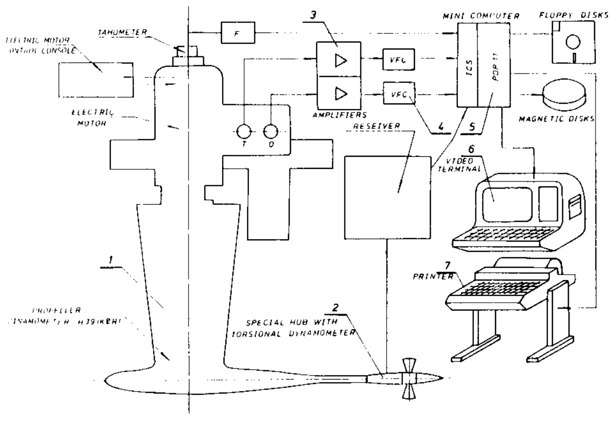


Fig. 1

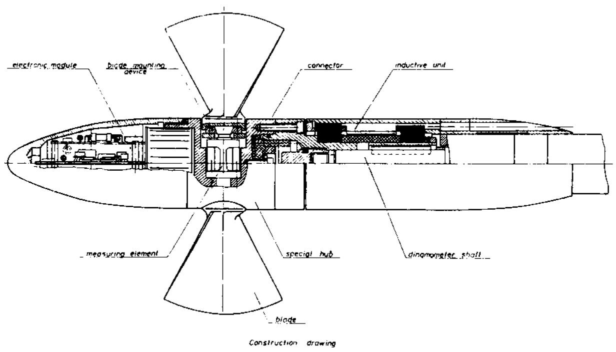


Fig. 2

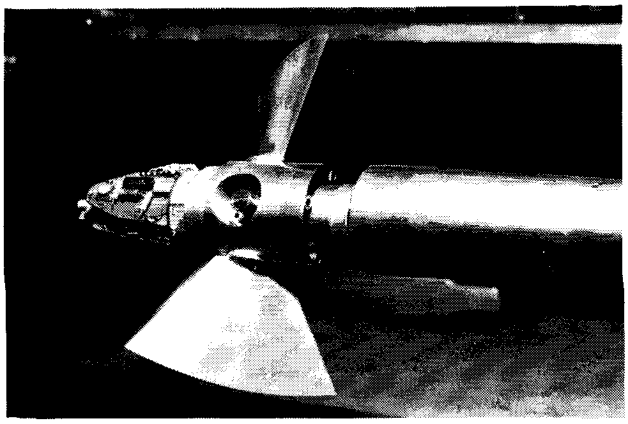


Fig 3

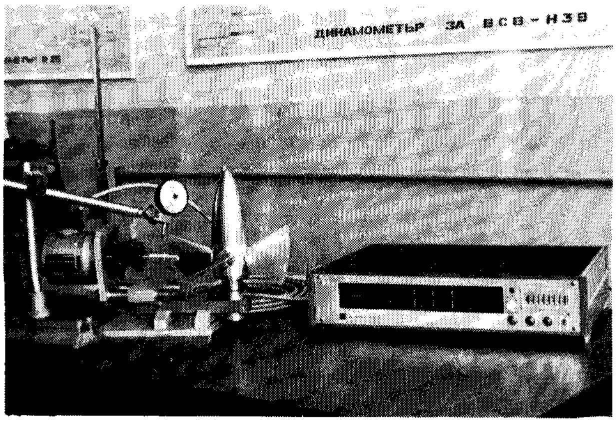


Fig 4

pitch variation from 0 to 360°.

In the fairwater bulk is installed an electronic modul which implements the following functions:

- rectifies and filtrates the powering voltage with 400 Hz frequency
- stabilizes the powering voltage and forms it as two-pole one ± V and GND
- amplifies the transducer signal
- converts the amplified AM signal into FM signal
- amplifies the signal power and transfers it for emission to the stationary part of the system

Energy for power supply and emission of the signal-carrying torque data is realized using inductive coupling, without direct contact. This allows simultaneous measurement both of the blade torque and thrust, as well as screw propeller moment, since additional friction is not generated.

The special hub with the blades and the electronic modul is easily dismantled from the inductive modul by un-screwing 4 screws. This operation is necessary when the blade pitch is being calibrated.

Fig. 4 presents the table for pitch angle calibration. A photoelectrical transducer and up - down counter with digital indication are used.

The measured values are recorded and processed using a mini-computer PDP 11/10.

Technical characteristics of the system

1. Basic H39 characteristics

- rated thrust	± 70 kpm
- rated torque	± 5.5 kpm
- maximum r.p.m.	50 r.p.m.

2. Basic characteristics of the device for torque measurement at blade base

- rated torque (changeable transducer)	± 0.5 kpm
	± 0.7 kpm
	± 1.0 kpm
	± 1.4 kpm

- output signal	FM, TTL
- initial frequency	~4000 Hz
- frequency deviation	± 2000 Hz
- non-linearity	~0.2 % FS
- hysteresis	~0.2 % FS
- hub diameter	0.06 m
- number of blades	4
- weight (without blades)	700 g

P. BOGDANOV, P. VASSILEV, S. BORISSOV, I. DRAGNEV - BSHC, Varna, Bulgaria.

SOME ASPECTS OF THE MEASURING EQUIPMENT AND DATA ACQUISITION SYSTEM OF THE BSHC OPEN WATER AREA

For the testing of large-scale free-running models of ships and push-trains as well as of half-scale models of lake vessels BSHC operates an outdoor test facility, the Open Water Area (OWA), at the near-by Varna Lake, 1.5 km away from the laboratory. (Fig. 1.)

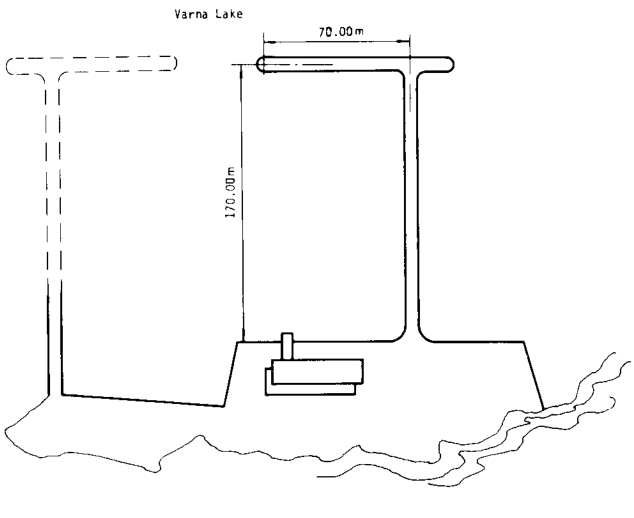


Fig 1 Scheme of the open water area

The dimensions of the open water area are: length 170 m, width 160 m and depth 3 m.

One of the basic problems, connected with the tests of free-running models and offshore structures carried out in the lake, is that of obtaining a steady flow of experimental data throughout the whole test-cycle. Having in mind that the process of data acquisition and processing is completed in the PDP 11/34 computer centre, which is situated in the close vicinity of the manoeuvring and seakeeping basin (MSB), two basic alternatives have been selected.

<u>Alternative No 1 (Block-Diagram in Figure 2)</u>

In the diagram the items marked are as follows:

1 - Mobile minicomputer centre

2 - Mobile ultrasonic system for trajectory determination on the OWA

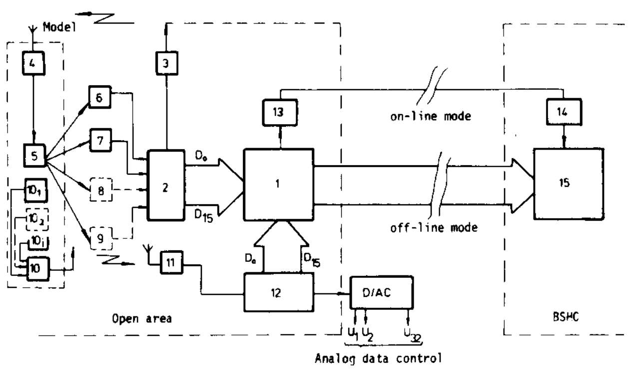


Fig 2 Alternative No. 1 - Block-Diagram

3 - Synchronization radio transmitter

4 - Synchronization audio receiver

5 - Hydroacoustic transmitter

6:9 - Hydroacoustic receivers

10 - Telemetry radio transmitter

$10_1:10_i$ - Sources of analog measuring signals (up to 32 channels)

11 - Telemetry radio receiver

12 - Telemetry decoder/interface

13,14 - High speed mod/dem unit

15 - PDP 11/34 computer centre

The structure described here-in is expected to be flexible enough to meet the forthcoming experimental problems in two possible modes, namely: in off-line mode, using the mobile microcomputer centre as a preliminary data storage unit of floppy disk carrier, and the cycle of processing and obtaining of the final results carried out later on PDP 11/34; in on-line mode, regarding the microcomputer centre as a terminal in the frame of PDP 11/34 by use of a high speed modulator/demodulator unit. In both cases all preliminary data acquisition is usually carried out in the field at OWA, as well as the corresponding synchronization of the instrumentation situated on the model to that on shore.

Alternative No 2 (Block-Diagram on Figure 3)

The block-diagram contains the following equipment:

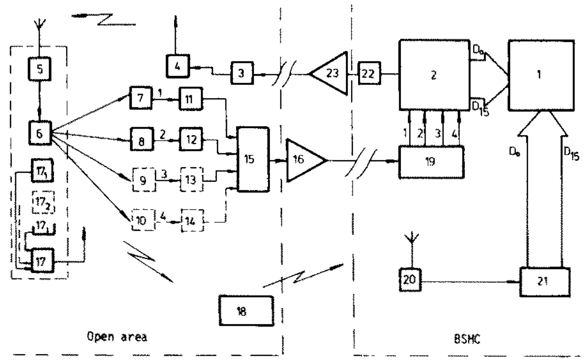


Fig 3 Alternative No. 2 - Block-Diagram

1 - PDP 11/34 computer centre

2 - Ultrasonic system "Trajectoria"

3 - Interlock pulse demodulator

4 - Synchronizing radio transmitter

5 - Synchronizing radio receiver

6 - Hydroacoustic transmitter

7:10 - Hydroacoustic receivers

11:14 - Modulator units

15 - Mixer stage

16 - Amplifier stage

17 - Telemetry radio transmitter

$17_1:17_i$ - Sources of analog measuring signals (up to 32 channels)

18 - Retransmitter (optional)

19 - Demodulator unit

20 - Telemetry radio receiver

21 - Telemetry decoder/interface unit

22 - Interlock pulse of USS "Trajectoria" system modulator

23 - Amplifier stage

In this case the on-line mode only is possible. The determination of the model trajectory is carried out by the basic unit, situated in the PDP 11/34 computer centre. The system interlock and timing pulse trains are transmitted in both directions by modulator/demodulator units, and the analog data is telemetry set (optionally via retransmitter unit) directly to the computer centre. The mod/dem structure is created in the telephone frame of BSHC, using two posts at OWA and two in MSB.

All data acquisition, processing and storage of the final results is carried out in the PDP 11/34 computer centre.

P. BOGDANOV, V CHOTUKOV and
M. STEPHANOV - BSHC, Varna, Bulgaria

TELEVISION SYSTEM FOR HYDRODYNAMIC INVESTIGATIONS

1. Application

The BSHC television system has a wide range of application in ship hydrodynamics and contributes to the considerable increase in the volume and quality of the experimental data.

The major fields of application of the television system are as follows:

1.1. Above-water visualization of the tests in all experimental facilities.

1.2. Underwater visualization of the tests of ship and screw propeller models, as well as of trawls and other fishing facilities.

1.3. Flow visualization of the model hull.

1.4. Tests documentation by means of video records.

1.5. Qualitative evaluation of a number of physical values.

1.6. Non-contact measurement of complex geometry objects' parameters.

1.7. Measurement of areas and geometric dimensions.

1.8. Recording of the time-history of the phenomena investigated.

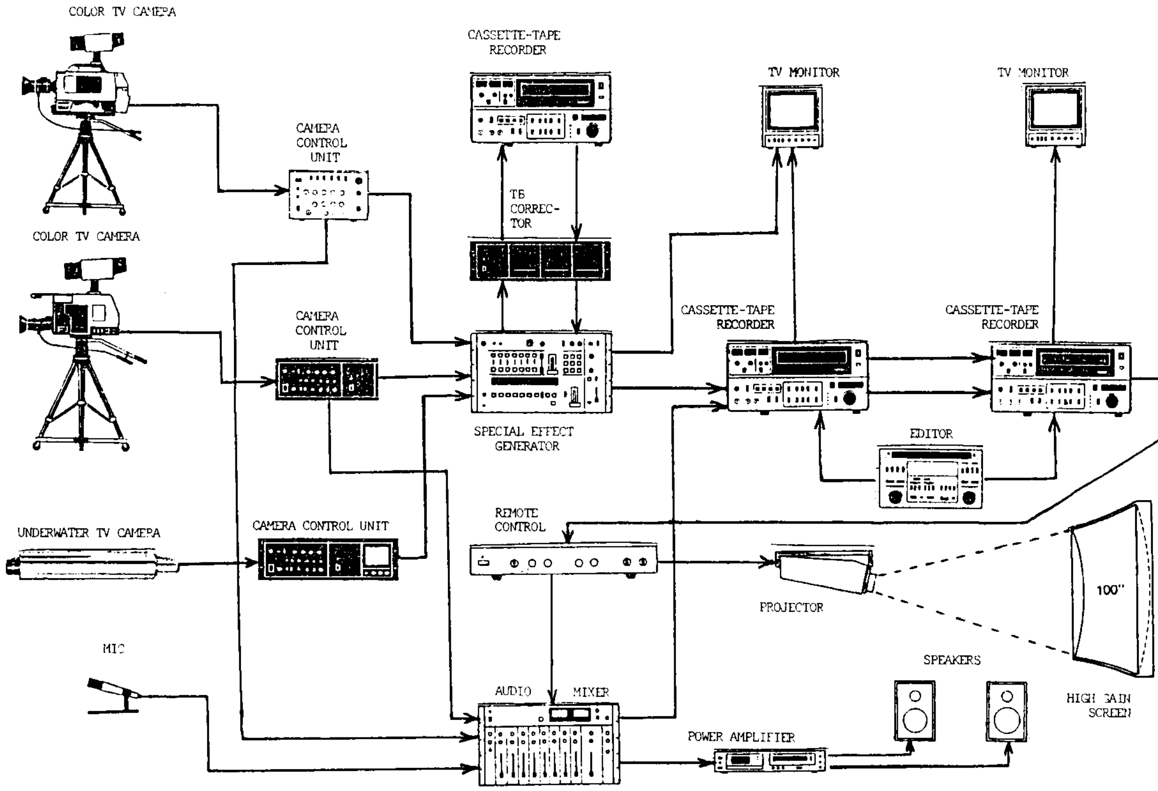
1.9. Projection of the recorded tests on different time scales.

1.10. Recording of the tests on the client's order.

Moreover, the video-projection system (with a 100" screen), connected to the TV system, allows the presentation of experimental results or video-records before a large audience.

2. Composition and Features

As is seen from the figure enclosed, the TV system consists of professional TV equipment: colour TV camera, underwater TV camera (B/W), video recorders, video monitors, time-base corrector, audio subsystem, video projection system, special effects generator and additional appliances.



BSHC TELEVISION SYSTEM FOR HYDRODYNAMIC INVESTIGATIONS

3. Specification

3.1. Colour TV cameras

Type:	3-tube (R,G,B)
Resolution:	650 lines
Signal-to-noise-ratio:	better than 55 dB
Sensitivity:	2000 Lux, F4 min 40 Lux F 1.6
Optics:	11-110mm/1.6F
Scanning system:	625 lines, 2:1 interlace, 25 fr/sec
Signal system:	CCIR standards, PAL colour system

3.2. Underwater TV camera

Receiving tube:	Newvicon - 2/3"
Resolution:	better than 600 lines
Signal system:	CCIR (625 lines, 50 fields)
Optics:	zoom lens 12.5 - - 75 mm/F 2.8

3.3. Cassette-tape recorders

Resolution:	340 lines (black-white) 250 lines colour
Signal-to-noise ratio:	better than 46 dB
Audio signals:	50 - 15000 Hz, S/N ratio: 48 dB
Signal system:	PAL/SECAM/NTSC$_{4.43}$

3.4. Special effects generator

Colour system: PAL

Switching system: vertical blanking switcher

Effects: MIX, WIPE (6 wipe patterns), EXT KEY, Downstream keyer, background colour

3.5. Automatic editor

- bidirectional film style searching
- full automatic editing control
- preview function
- auto edit accuracy ± 2 frames

3.6. TV monitors (high resolution)

Colour system: PAL/SECAM/NTSC

Signal system: CCIR (625 lines, 50 fields)

Resolution: 550 lines

3.7. Time-base (TB) corrector

Colour system: PAL

Signal system: CCIR

Window correction: 29H, 8 bits
Y:10.9 MHz/C:5.54 MHz sampling

3.8. Video projection system

Projector: 3 picture tubes (R,G,B)
Direct projection system

Projection lenses: F1.0/130 mm

Light output: 200 lumens

Screen/ picture size: 100"(2.54 m) measured diagonally

Picture brightness: more than 65 fl

Throw: 2.48 m

Colour system: PAL/SECAM/$NTSC_{4.43}$

Resolution: 600 TV lines (R,G,B-inputs)

Blue-only mode: possible (for computer graphics and 2000- 80 char x 25 lines - computer-generated letters)

P. BOGDANOV, M. STEPHANOV, V. CHOTUKOV and M. MIKHAILOV - BSHC, Varna, Bulgaria.

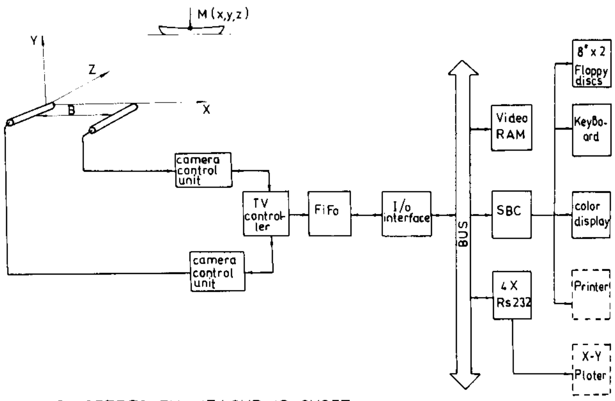
THE BSHC STEREO TV MEASURING SYSTEM

1. Application

The stereo television system of BSHC is specially developed for application in experimental ship hydrodynamics. With it, the three-dimensional co-ordinates of points on the investigated submerged and surface models can be measured. Main feature of the stereo TV system is its usage for non-contact measurements in these cases, where the traditional measuring methods are inapplicable or practically difficult to apply, e.g. involving measuring the form and dimensions of trawls and other fishing facilities, investigating off-shore structures, mooring lines, etc.

2. Composition

The system comprises (as shown in the accompanying Figure) two standard TV cameras with camera control units (underwater or surface) as well as the specialized devices developed at BSHC: TV controller, FiFo Buffer Memory, I/O interface and micro-computer system.



BSHC STEREO-TV MEASURING SYSTEM

3. Specification

3.1. TV controller

Resolution: H-9 bits V-9 bits

Input signals: CCIR, 625 lines, 2:1 interlaced, 25 frames/sec

3.2. Buffer memory

Type: FIRST-IN-FIRST-OUT (FiFo)

Memory size: 512 words, 20 bit each

3.3. Microcomputer system

CPU - 8/16 bit
RAM - 64K (265K extension possible)
VIRTUAL DISK 288K
4 x RS232C ports
Colour graphic display: 512.256 points, 8 colours

Hard copy printer, H-Y plotter, Joy-stick

Programme languages: GRAPHIC PASCAL, GRAPHIC BASIC

Reference

[1] Stephanov, M., Mikhailov, M.: "Investigation of Trawl and Fishing Facilities Models by Stereotelevision Method", 13th SMSSH, Varna, 2-5 Oct. 1984 (to be published).