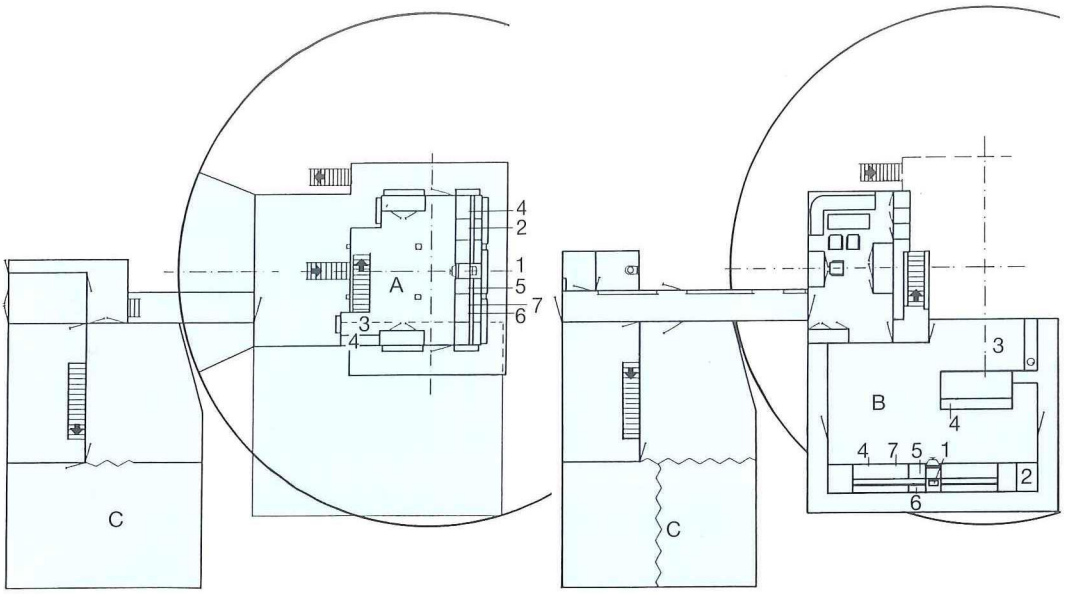
MARITIME RESEARCH INSTITUTE NETHERLANDS




# SIMULATORS

*A. Bridge with outside view*
*B. Bridge Instrument Simulator*
*C. Vessel Traffic Service Training Simulator*

*1. Compass and steering unit*
*2. Radar (with ARPA)*
*3. Chart room*
*4. Decca*
*5. Telegraph*
*6. Doppler log*
*7. RTF*

OUTSIDE VIEW SYSTEM (1970) : Shadowgraph projection system.
Field of view: 360° horizontal, +25° to −15° vertical.
Resolution: 2 arc-minutes.
Position accurracy: 6 arc-minutes
Brightness: 10 Lux.
Fog: variable visibility range.
Bridge size: 6 × 4 m.

INSTRUMENT SIMULATOR (1976) : Bridge size: 10 × 4 m.
Wide range climate control.

GRAPHIC DISPLAY SYSTEM (1983) : Panoramic view.
High resolution graphic displays.
Field of view adaptable 90° - 240°.

In all systems a great variety of bridge equipment is available as there are: Compass, Telegraph, Rate of turn indicator, Decca, Radar (with ARPA), Doppler log, etc.

MATHEMATICAL MODELS : Standard available VLCC, containerships (2nd and 3rd generation), bulk carriers, LNG carriers all at various water depths and of various sizes, single and twin screw versions and diesel or turbine engines.
Other models on request.

SPECIAL EFFECTS : Wind, waves (swell), current, bottom and bank suction, mud, passing of ships, tugs (max. 6), backing.
Combined and interactive use of 2 simulators.

Maritime Research Institute Netherlands (MARIN)
Haagsteeg 2, P.O. Box 28, 6700 AA Wageningen, The Netherlands
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## SIMULATORS AND THEIR USE

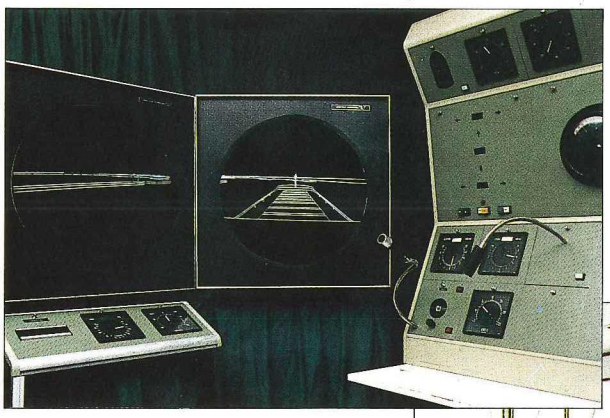
In the manoeuvring of ships the human operator plays a dominant role. It is found that 60 - 80 % of accidents with ships are caused by human failures. A manoeuvring simulator makes it possible to incorporate the human behaviour into the experiment. Furthermore a simulator can be used to change the human behaviour by training the navigator in handling ships in all kinds of situations.

Three factors are important for a good simulation:
- Mathematical models
- Visualization
- Analysis of results

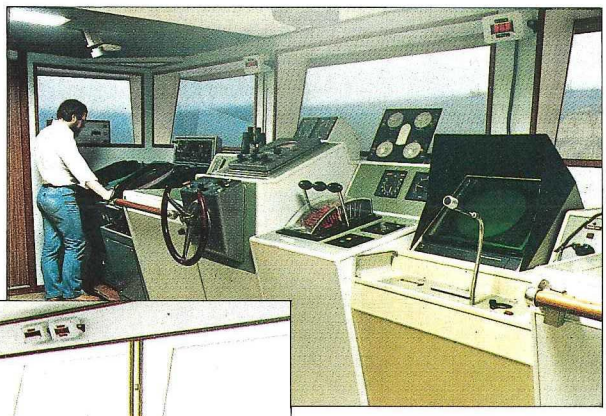
As MARIN is one of the leading institutes in hydrodynamic research the use of good mathematical models is assured.

The three simulators MARIN has available i.e. the outside view, the instrument and the graphic display simulator guarantee that the most adequate and cost effective solution can be applied.

Research concerning simulators and especially navigational research for port and fairway design needs the analysis of the test results and its interpretation. As the human factor in such 'man-machine-environment' systems plays a dominant role statistical analysis techniques are used. Statistical here means that, based upon random tests, a well-founded judgement about the probability of the occurrence of certain events (bottom contacts, exceeding channel limits, etc.) is possible. MARIN's many years of experience with this kind of research and analyzing techniques stand for good and reliable results.



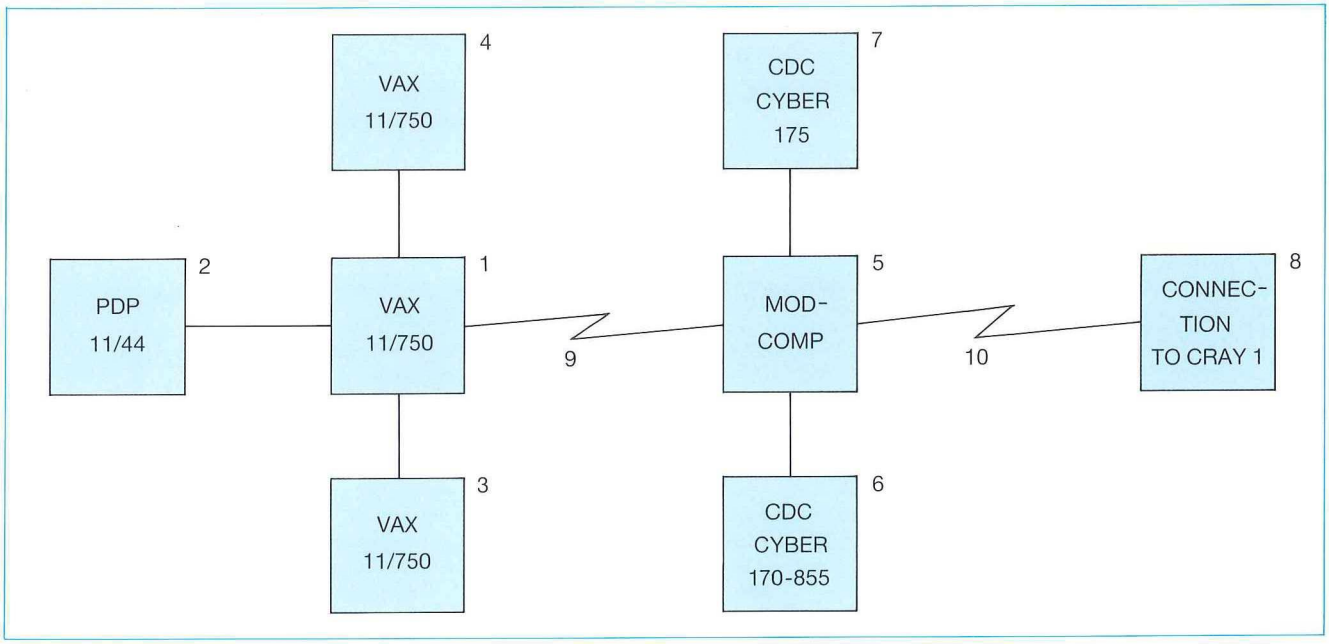
*Graphic display.*



*Outside view simulator.*

*Instrument simulator.*

# COMPUTER NETWORK




1. *Concentrator for terminals and computers*
2. *Process computer vacuum towing tank*
3. *Process computer vessel traffic simulator*
4. *Computer for database applications*
5. *Concentrator for terminals and computers*
6. *Mainframe for batch-processing*
7. *Mainframe for interactive processing*
8. *Supercomputer connection*
9. *48 Kb/s network link*
10. *72 Kb/s network link*

*Items 5 t/m 10 are managed in cooperation with two other research institutes.*

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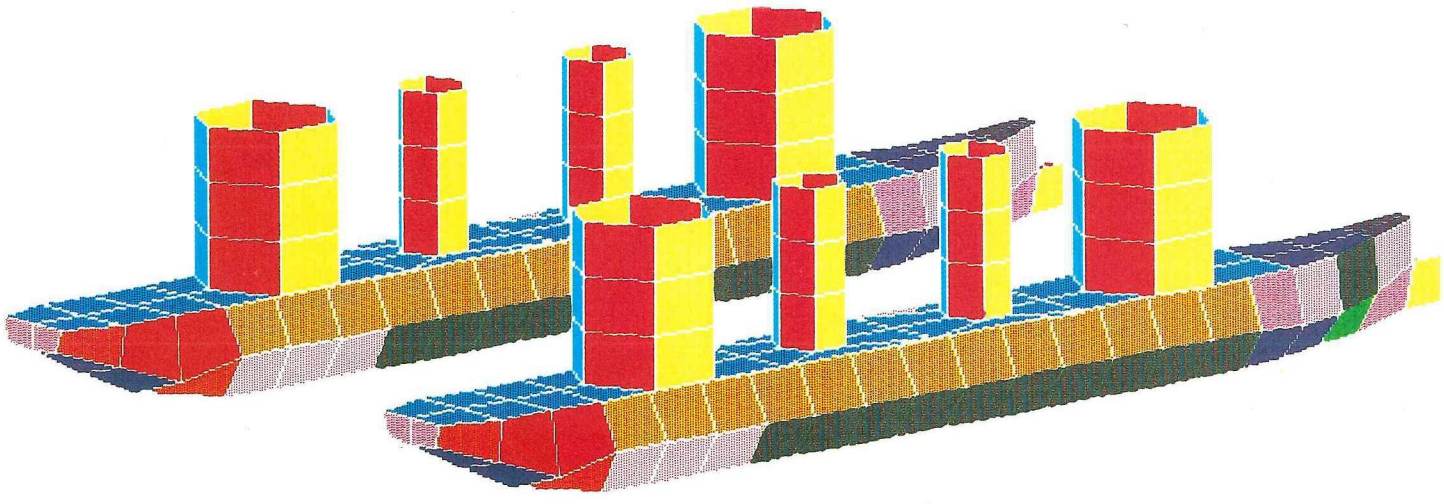
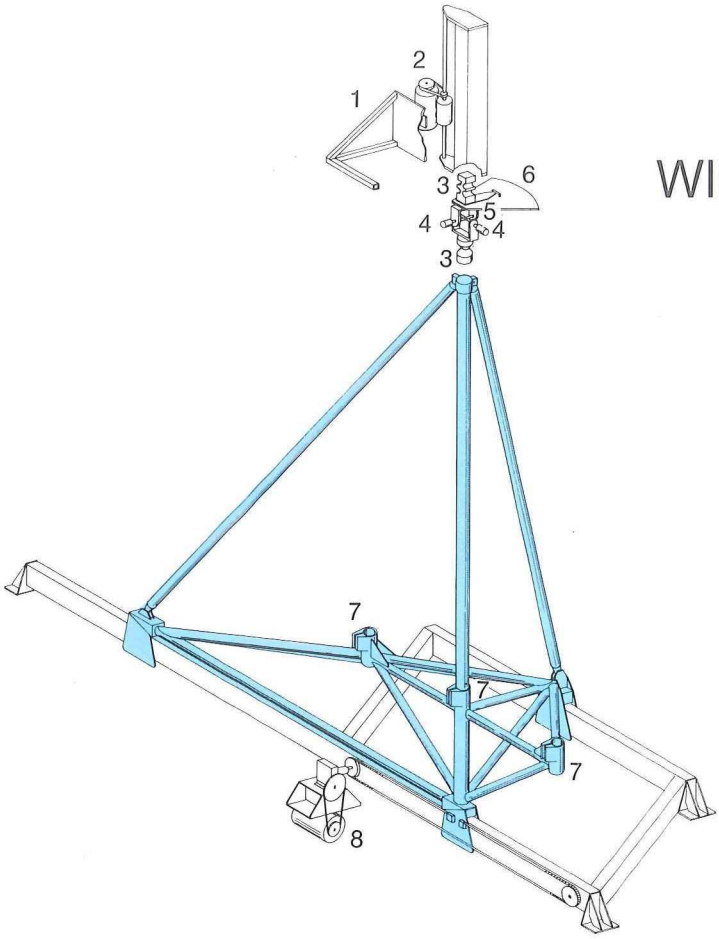
PERIPHERALS : 50 Interactive terminals.
Card reader.
Line printers.
Tape punch.
Drum plotter.
Drafting machine 1.80 × 9m.
Digitizing system.

CONNECTION TO MEASURING FACILITIES : On line: VT, VTS.
Magnetic tape transport: DT, BT, HT, ZT, GT.

APPLICATIONS : Mathematical modelling of hydrodynamics.
Geometric modelling.
Statistical treatment of experimental data.
Signal processing.
Ship- and propeller design.
Resistance and propulsion calculations.



*Computer generated output of semi submersible.*




# WINDFORCE DYNAMOMETER

1. *Towing carriage*
2. *Motordrive vertical carriage*
3. *Transducers*
4. *Rotational potentiometers*
5. *Gimbals*
6. *Drift angle setting*
7. *Mast fixation*
8. *Motordrive horizontal carriage*

## DESCRIPTION

The windforce dynanometer is based on the principle of the free running test. The advantage of this approach is a short testing time and direct available test results.
The test set-up ensures that every run results in a realistic sailing attitude of the model. The towing force is applied in the same place and direction as the wind force. To realise this the dynamometer is equipped with two servo systems which govern the horizontal and vertical carriages.
The command signals are obtained from the lower transducer which measures the mast torque and the longitudinal force in the mast. These forces are kept zero in accordance with the actual full-scale situation.
The gimbals provide the additional freedom required to allow the free-running, realistic sailing attitude to be attained.
The upper transducer measures the drag and lift forces.

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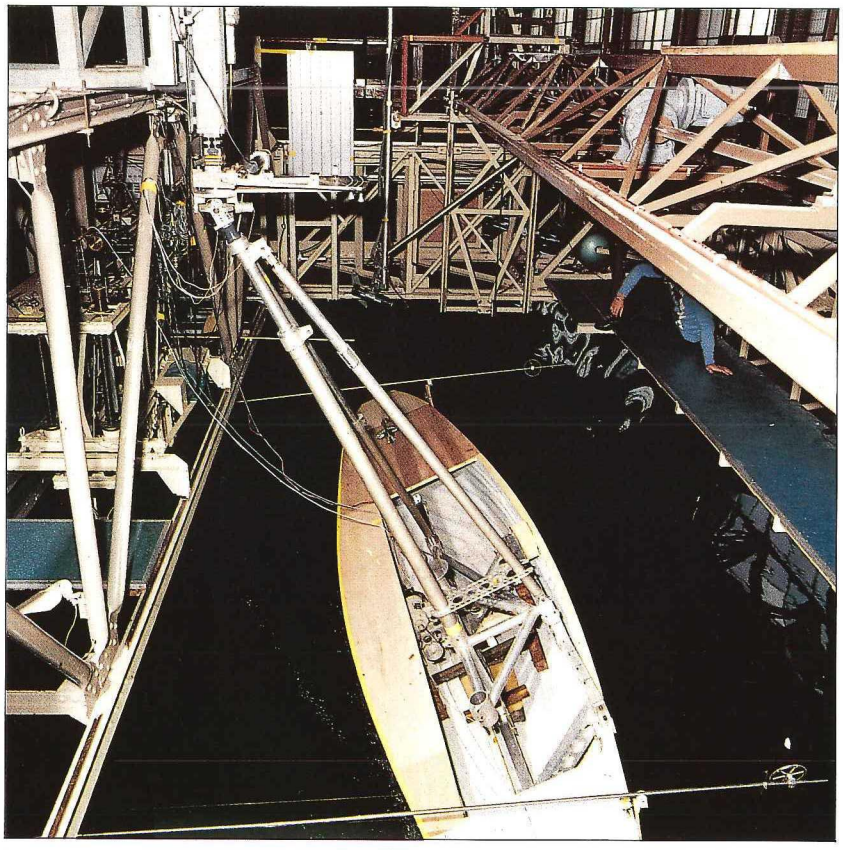
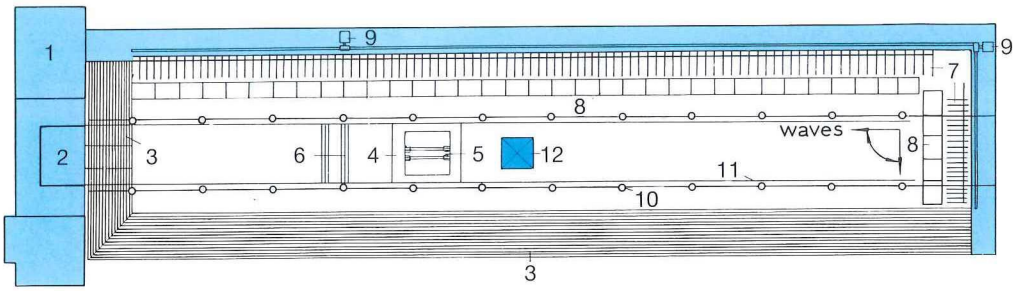
| | | |
|---|---|---|
| DYNAMOMETER INPUT | : | Model dimensions<br>Carriage speed<br>Yaw angle (0.1° resolution)<br>Rudder angle and trim tab angle |
| DYNAMOMETER OUTPUT | : | Mast position<br>Trim angle<br>Heel angle<br>Drag force<br>Lift force |

MISCELLANEOUS

The dynamometer is connected to the data acquisition system of the towing carriage: it can also be used to study, e.g., the effect of waterdepth.



# SEAKEEPING BASIN (1956)




1. *Workshop*
2. *Working pond*
3. *Beach*
4. *Carriage*
5. *Sub-carriage*
6. *Auxiliary carriage*
7. *Wave generator*
8. *Wire mesh package*
9. *Wave generator motor*
10. *Support piles*
11. *Rails*
12. *Pit (4.5 × 4.5 m, depth 3.5 m below basin bottom)*

| | | |
|---|---|---|
| DIMENSIONS | : | 100 m × 24.5 m. |
| CARRIAGE | : | Manned, motor-driven. |
| TYPE OF DRIVE SYSTEM AND TOTAL POWER | : | Thyristor type power supply, 4 × 5 kW. |
| MAXIMUM CARRIAGE SPEED | : | 4.5 m/s. |
| OTHER CAPABILITIES | : | Optical tracking system mounted on sub-carriage inside the main carriage to extend the measurement range.<br>Auxiliary carriages to accommodate models of large offshore structures.<br>PMM equipment. |

| | | |
|---|---|---|
| WAVE GENERATOR CAPABILITY | : | Regular and irregular waves.<br>Wave period 0.7 - 3 s.<br>Wave direction 180 - 270 and 0 - 90 deg. and any angle in between.<br>Wave height up to 0.3 m (significant). |
| WAVE-MAKER TYPE AND EXTENT | : | Flap type, on long and short side. |
| BEACH TYPE | : | Lattice on circular arc plates. |
| WAVE MEASUREMENTS | : | Portable electric resistance type wave probes. |
| CURRENT | : | System being developed. |
| WIND | : | Generated by portable fans. |
| WATER DEPTH | : | Adjustable between 2.4 and 2.5 m. |

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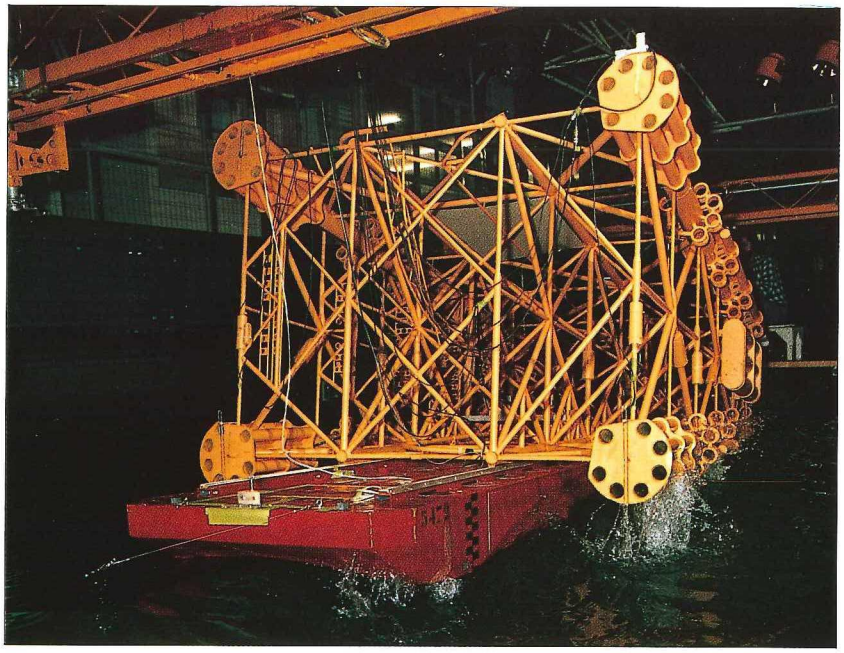
INSTRUMENTATION : Data recording on magnetic tape and/or UV paper strip charts.
First analysis on line by PDP 11/23 computer.
Number of channels: maximum 64.
Number of samples: adjustable.
High speed film and video recording equipment available.

MODEL SIZE RANGE : Model length of 2 - 4.5 m for moving objects and up to 6 m for moored objects.
Floating structures of any kind, size depending on water depth and wave conditions.

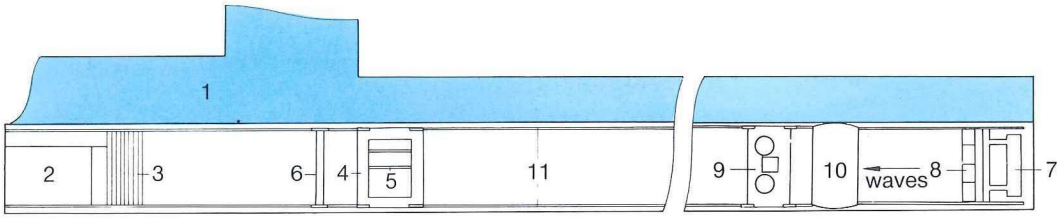
MODEL TRACKING TECHNIQUES : Self-propelled ship models (steered by autopilot) and floating objects are monitored by optical tracking system.

TESTS PERFORMED :
- Resistance and self-propulsion tests of ship models in waves.
- Oscillation (PMM) tests and tests in waves with a restrained model to determine the hydrodynamic coefficients.
- Launching, installation and sea transport tests of offshore constructions.
- Tests with moored or fixed objects to determine the motions and loads due to waves, wind and current.



*Sea transport tests with a 18,000 t jacket structure loaded on a barge.*

# BASIN FOR UNCONVENTIONAL MARITIME CONSTRUCTIONS - HIGH SPEED BASIN (1965)




1. *Workshop*
2. *Working pond with sluice gate*
3. *Beach*
4. *Main carriage*
5. *Sub-carriage*
6. *Auxiliary carriage*
7. *Wave generator*
8. *Wire mesh package*
9. *Compressor carriage*
10. *High speed carriage*
11. *Rails*

| | | |
|---|---|---|
| DIMENSIONS | : | 200 m × 4 m. |
| CARRIAGES | : | Manned, motor-driven main carriage (a).<br>Unmanned, jet-driven high speed carriage (b). |
| TYPE OF DRIVE SYSTEM AND TOTAL POWER | : | Thyristor power supply, 210 kW (a).<br>Driven by waterjet released from pressure vessel at 350 bar (b). |
| MAXIMUM CARRIAGE SPEED | : | 15 m/s (a); 30 m/s (b). |
| OTHER CAPABILITIES | : | Air-lubricated piston connection between model and carriage.<br>PMM equipment. |

| | | |
|---|---|---|
| WAVE GENERATOR CAPABILITY | : | Regular and irregular waves.<br>Wave period 0.3 - 5 s.<br>Wave direction 0 - 180 deg.<br>Wave height up to 0.4 m (significant). |
| WAVE-MAKER TYPE AND EXTENT | : | Hydraulic flap type, on short side. |
| BEACH TYPE | : | Lattice on circular arc plates. |
| WAVE MEASUREMENTS | : | Portable electric resistance type wave probes and servo-controlled wave probes. |
| WIND | : | Generated by portable fans. |
| WATER DEPTH | : | Adjustable between 3.5 and 4.0 m. |

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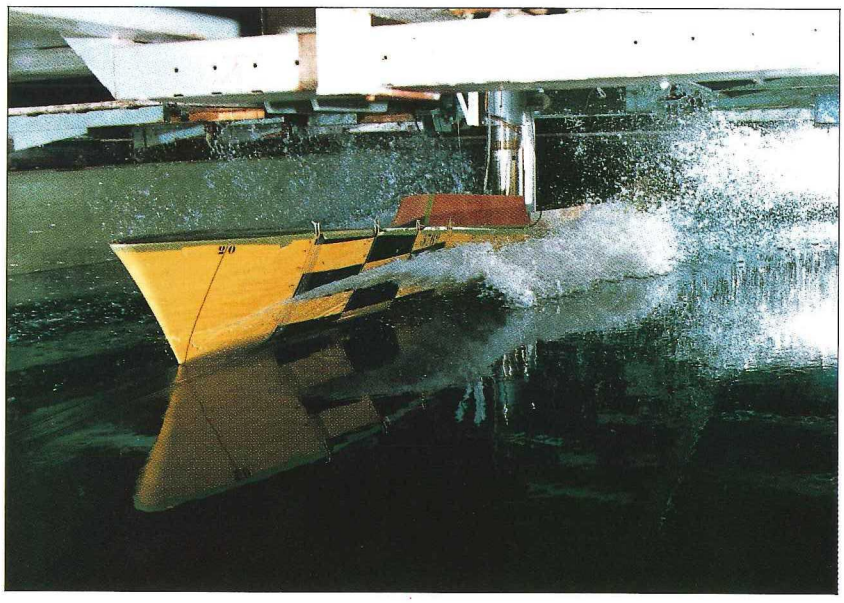
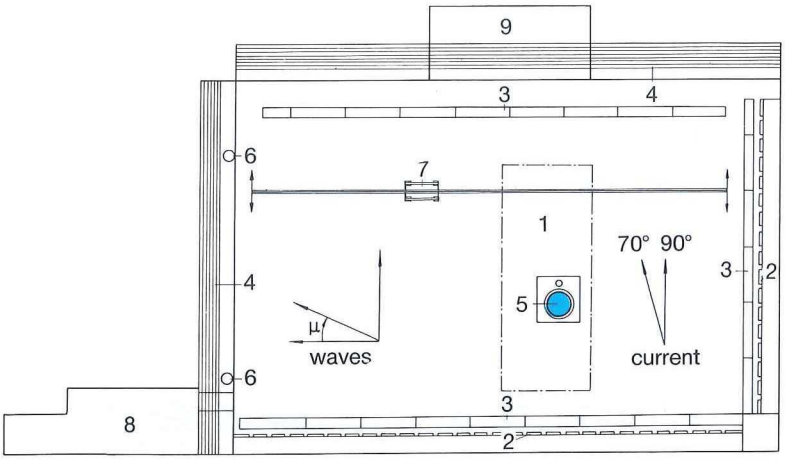
| | | |
|---|---|---|
| INSTRUMENTATION | : | Data recording on magnetic tape and/or UV paper strip chart.<br>First analysis on line by PDP 11/23 computer.<br>Number of channels: maximum 64.<br>Number of samples: adjustable.<br>High speed film and video recording equipment available. |
| MODEL SIZE RANGE | : | Ship model length 2 - 5 m.<br>Floating structures ranging from 0.2 to 3 m. |
| MODEL TRACKING TECHNIQUES | : | Air-lubricated bearings with potentiometers for resistance tests on fast displacement ships.<br>Model fixed to high speed carriage for very fast (planing) hulls.<br>Optical tracking systems for moored objects or self-propelled ships. |

TESTS PERFORMED :

- Resistance and self-propulsion tests in calm water and in waves of models of ships and high speed craft.
- Testing of hydrofoils at high speed.
- Seakeeping tests on high speed ships.
- Launching, up-ending, installation, template mating, and critical wave tests for offshore platforms.
- Stability tests for offshore structures.
- Oscillation (PMM) tests and tests in waves with restrained model to determine hydrodynamic coefficients.



*Tests in waves with a high speed ship. One of a family of hull forms, studied in a joint program with the Dutch and U.S. Navy.*




# WAVE AND CURRENT BASIN (1965)

1. *Actual measurement area*
2. *Wave generator*
3. *Wire mesh package*
4. *Beach*
5. *Pit (diameter 3.1 m, maximum depth 2.3 m below tank bottom)*
6. *Laser tracking device*
7. *Monorail carriage*
8. *Working pond*
9. *Control room*

| | | |
|---|---|---|
| DIMENSIONS | : | 60 m × 40 m. |
| CARRIAGE | : | Monorail, unmanned towing carriage with controlled model release for manoeuvring tests. |
| MAXIMUM CARRIAGE SPEED | : | 2.5 m/s. |
| OTHER CAPABILITIES | : | Sub-carriage inside actual measurement area to extend range of optical tracking system. |

| | | |
|---|---|---|
| WAVE GENERATOR CAPABILITY | : | Regular and irregular waves.<br>Wave period 0.5 - 3 s.<br>Wave directions 0 - 90 deg.<br>Wave height up to 0.3 m (significant). |
| WAVE-MAKER TYPE AND EXTENT | : | Flap type, on long and short side. |
| BEACH TYPE | : | Lattice on circular arc plates, adjustable in height. |
| WAVE MEASUREMENTS | : | Portable electric resistance type wave probes. |
| CURRENT | : | Speed 0.1 - 0.6 m/s over full basin width.<br>Direction 70 - 90 deg. or 250 - 270 deg. |
| WIND | : | Generated by portable fans. |
| WATER DEPTH | : | Adjustable, maximum 1.2 m. |

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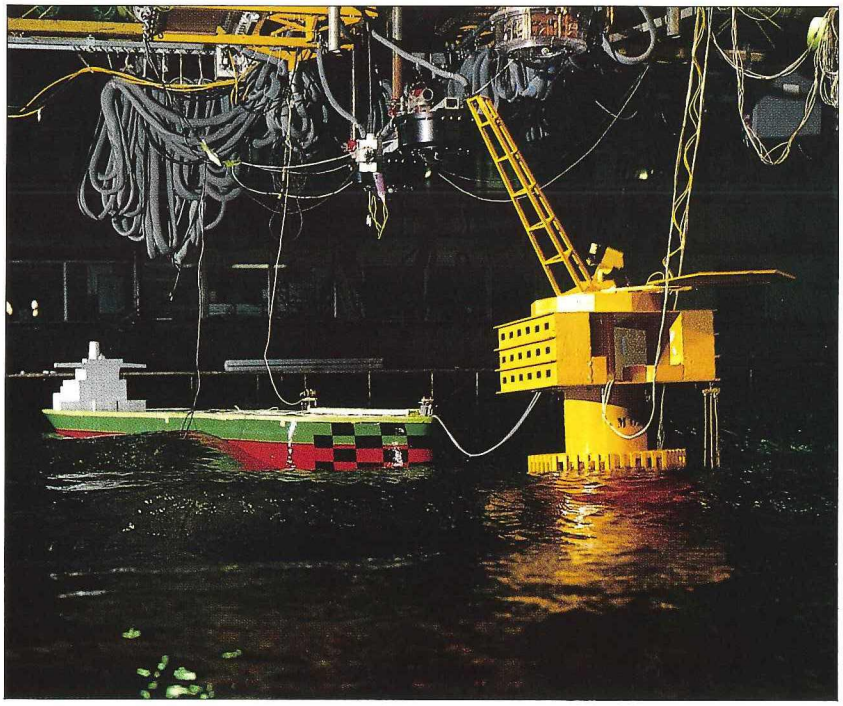
| | | |
|---|---|---|
| INSTRUMENTATION | : | Data recording on magnetic tape and/or UV paper strip chart.<br>First analysis on line by PDP 11/34 computer.<br>Number of channels: maximum 64.<br>Number of samples: adjustable.<br>High speed film and video recording equipment available. |
| MODEL SIZE RANGE | : | Ship model length 3 - 6 m.<br>Floating structures of any kind, size depending on water depth and wave condition, usually between 0.2 m for buoys and 4 m for ships. |
| MODEL TRACKING TECHNIQUES | : | Two laser beams automatically track the model during free manoeuvring tests.<br>Optical tracking systems for moored objects. |

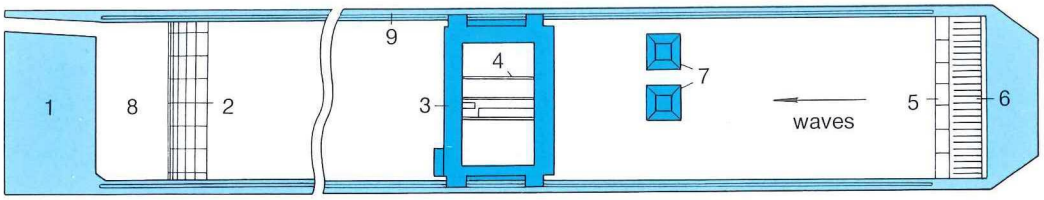
TESTS PERFORMED :

- Ship manoeuvring tests (turning circle and spiral tests) in calm water and in wind, waves and current.
- Feasibility manoeuvring tests in/near harbour entrances, beaches and other obstacles.
- Tests to determine motions, mooring loads and loads on moored or fixed objects due to wind, waves and current.



*Semi-submersible early production concept. Displacement about 22,500 t. Offtake tanker 50,000 TDW.*

# SHALLOW WATER BASIN (1958)




1. *Working platform*
2. *Beach (removable)*
3. *Carriage*
4. *Sub-carriage*
5. *Wire mesh package*
6. *Wave generator*
7. *Pits (each 3 × 3 m, depth 2.2 m below tank bottom)*
8. *Working pond*
9. *Walkway with rails*

| | | |
|---|---|---|
| DIMENSIONS | : | 220 m × 15.8 m. |
| CARRIAGE | : | Manned, motor-driven. |
| TYPE OF DRIVE SYSTEM AND TOTAL POWER | : | AC Thyristor power supply, 4 × 15 kW. |
| MAXIMUM CARRIAGE SPEED | : | 3 m/s. |
| OTHER CAPABILITIES | : | PMM equipment. |

| | | |
|---|---|---|
| WAVE GENERATOR CAPABILITY | : | Regular and irregular waves.<br>Wave period 0.5 - 3 s.<br>Wave direction 0 - 180 deg.<br>Wave height up to 0.25 m (significant). |
| WAVE-MAKER TYPE AND EXTENT | : | Flap type, on short side. |
| BEACH TYPE | : | Adjustable in height, lattice type.<br>Portable electric resistance type wave probes. |
| WIND | : | Generated by portable fans. |
| WATER DEPTH | : | Adjustable, maximum 1.15 m for calm water, 1.0 m for wave tests. |

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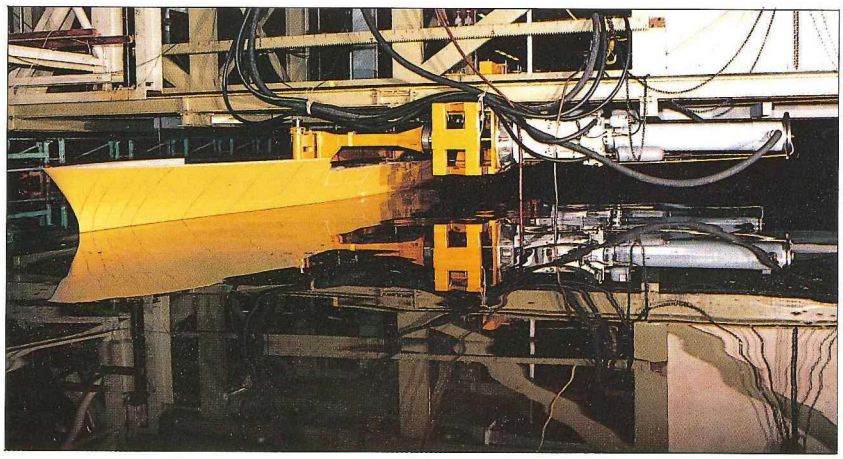
| | | |
|---|---|---|
| INSTRUMENTATION | : | Data recording on magnetic tape and/or UV paper strip chart.<br>First analysis on line by PDP 11/34 computer.<br>Number of channels: maximum 64.<br>Number of samples: adjustable.<br>High speed film and video recording equipment available. |
| MODEL SIZE RANGE | : | Particularly equipped for inland waterways push-boat and tow configurations. Overall length of 26 m and total beam of 5.5 m is the largest as of yet tested.<br>Manoeuvring tests (zig-zag, PMM), model length up to 8 m.<br>Floating structures and mooring arrangements depending on water depth and wave conditions. |
| MODEL TRACKING TECHNIQUES | : | Objects are tracked by optical system. |

TESTS PERFORMED :

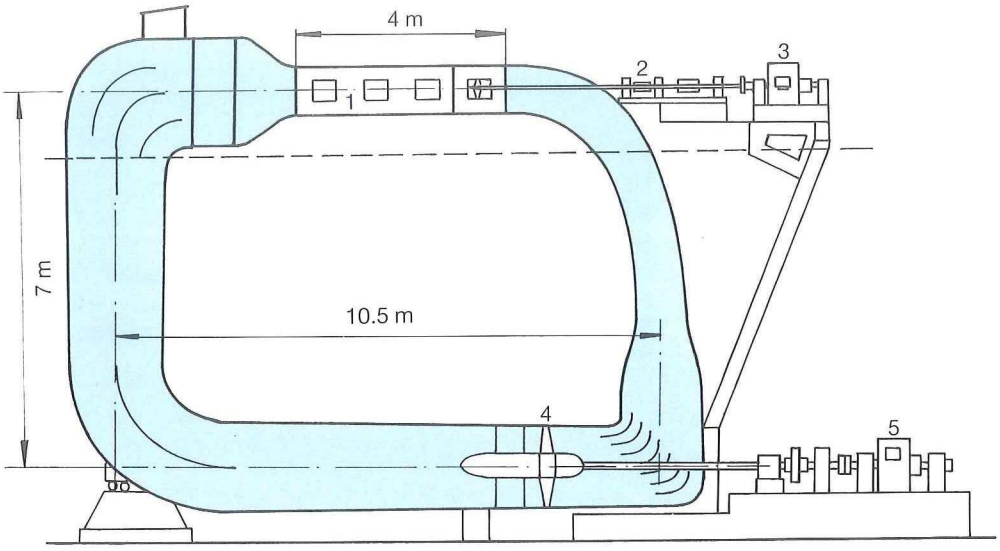
- Manoeuvring tests, zig-zag tests, stopping tests, PMM tests for determination of manoeuvring coefficients for input of the manoeuvring simulator.
- Resistance and self-propulsion tests especially for shallow water and/or narrow channels for ships and large push-tow fleets.
- Seakeeping tests with measurements of motions, wave loads and added resistance in waves for self-propelled ships.
- Behaviour of vessels in waves during beaching.
- Oscillation tests and tests in waves with a restrained model to determine hydrodynamic coefficients.
- Tests for moored and fixed objects to determine the motions, mooring forces and loads due to waves and wind.



*View on model mounted to hydraulic oscillator (PMM tests).*

# LARGE CAVITATION TUNNEL (1941)

## Modified 1979




1. *Test section*
2. *Thrust and torque dynamometer*
3. *Propeller motor*
4. *Axial flow impeller*
5. *Impeller motor*

| | | |
|---|---|---|
| DESCRIPTION | : | Vertical plane, closed recirculating, variable speed and pressure, deaerater. |
| TYPE OF DRIVE SYSTEM | : | 1.48 m Diameter fixed pitch four-bladed axial flow impeller, thyrister controlled, 220 kW, 1200 rpm (impeller 300 rpm). |
| PROPELLER MOTOR | : | Thyrister controlled, 184 kW, 3000 rpm. |
| WORKING SECTION MAX. VELOCITY | : | 10 - 11 m/s. |
| WORKING SECTION CHARACTERISTICS | : | Rectangular 0.9 m × 0.9 m with rounded corners, length 4 m. |
| PRESSURE RANGE | : | 10 - 180 kPa. |
| CAVITATION NUMBER RANGE | : | $\sigma_n = 0.2$ - 6. |

| | | |
|---|---|---|
| INSTRUMENTATION | : | Dynamometers, strain gauge elements, pressure transducers, hydrophones, 5-hole pitot tube, laser doppler velocity scanner, strobe lights, time lapse film recorder. |
| TORQUE AND THRUST DYNAMOMETERS | : | Hottinger strain gauges between motor and tunnel.<br>Thrust range ± 5000 N.<br>Torque range ± 500 Nm. |
| PROPELLER SIZE | : | Max. diameter 400 mm. |
| WAKE FIELD SIMULATION | : | Dummy model representing aft part of single screw ship fitted to top side (centre) of test section, or dummy model representing port or starboard aft part of twin screw ship fitted to one of the top corners in the test section; length of dummy models about 3 m. |

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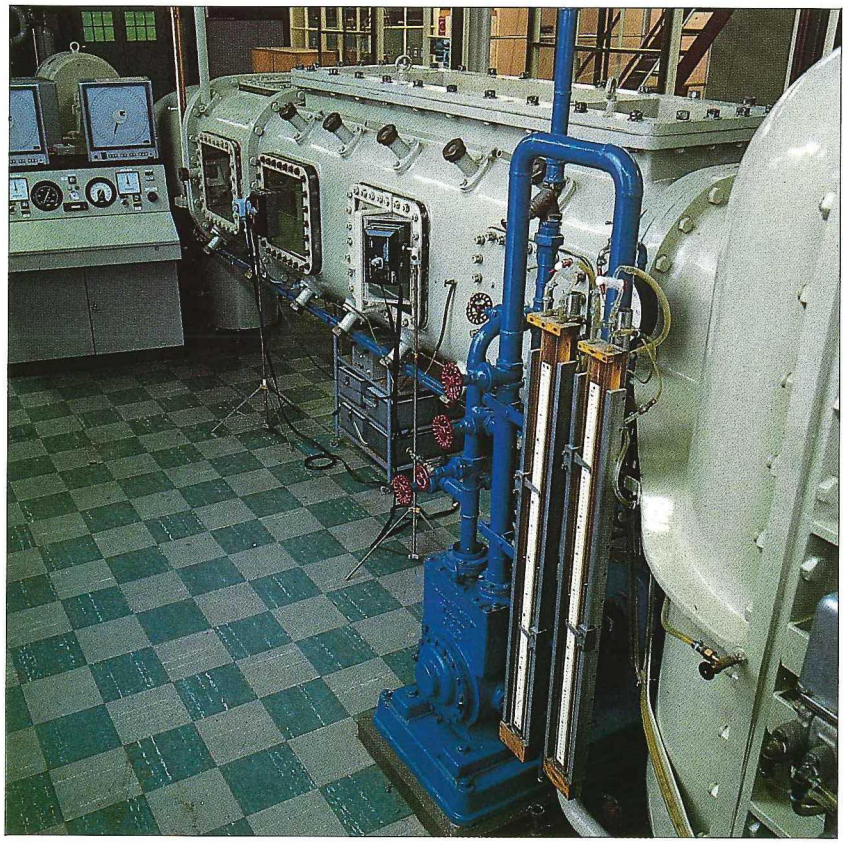
TESTS PERFORMED :

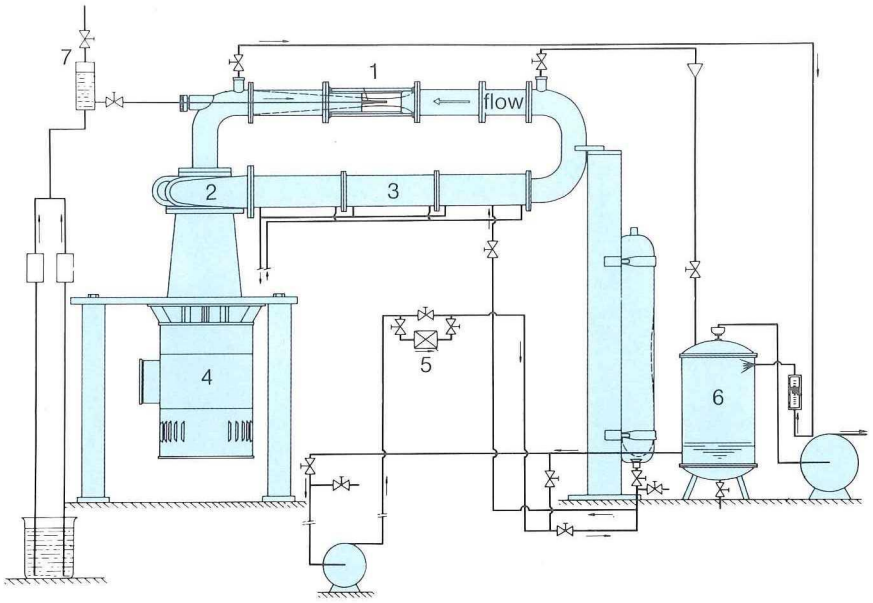
- Cavitation observation tests, cavitation inception measurements and performance tests with propellers in wake field behind dummy model or in oblique flow set-up.
- Hull-pressure fluctuation measurements.
- Propeller noise measurements.
- Blade spindle torque measurements.
- Measurement of forces and torques on nozzles, rudders, hydrofoils etc.
- Supercavitating propeller testing with right angle drive (up to 6000 rpm).

PUBLISHED DESCRIPTION :

- Witte, J.H. and Esveldt, J., 'Recent Improvements in the Large Cavitation Tunnel of the Netherlands Ship Model Basin', International Shipbuilding Progress, Vol. 13, No. 146, Oct. 1966 (NSMB Publ. No. 285).
- 12th ITTC Proceedings, Rome, 1969.



# HIGH SPEED CAVITATION TUNNEL (1965)




1. *Test section*
2. *Centrifugal pump*
3. *Heat exchanger*
4. *Pump motor*
5. *Filtration system*
6. *Deaeration system*
7. *Addition of special gases or liquids*

| | | |
|---|---|---|
| DESCRIPTION | : | Vertical plane, closed recirculating, variable speed and pressure, cooling/heating system, filtration system, deaeration system, addition of special gases or fluids. |
| TYPE OF DRIVE SYSTEM | : | Centrifugal pump (inlet/outlet diameter 125 mm), thyrister controlled, 58 kW, 3000 rpm. |
| TUNNEL FLUID CAPACITY | : | 0.06 $m^3$. |
| WORKING SECTION CHARACTERISTICS | : | Circular (a): diameter 40 mm.<br>Square (b): 50 × 50 mm with rounded corners.<br>Rectangular (c): 40 × 80 mm. |
| WORKING SECTION MAX. VELOCITY | : | 65 m/s (a), 40 m/s (b) or 35 m/s (c). |
| PRESSURE RANGE | : | 2 - 3000 kPa (a), 2 - 800 kPa (b) or 2 - 600 kPa (c). |
| CAVITATION NUMBER RANGE | : | $\sigma_0$ = 0.05 - 20. |
| TEMPERATURE RANGE | : | 10 - 80 °C |

| | | |
|---|---|---|
| INSTRUMENTATION | : | In-line holographic methods, laser techniques, strobe light, hydrophone, photomultiplier. |
| MODEL SIZE | : | Max. diameter of axisymmetric bodies 15 mm; max. chord length of hydrofoils 70 mm. |

Maritime Research Institute Netherlands (MARIN)
Haagsteeg 2, P.O. Box 28, 6700 AA Wageningen, The Netherlands
Phone: +31/ 8370 93911, Telex: 45158 nsmb nl
Telephone copier / Telefax: +31/ 8370 93245

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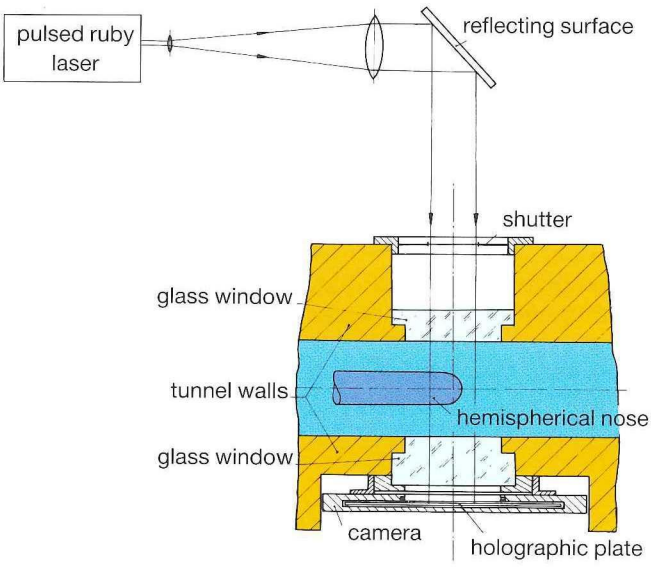
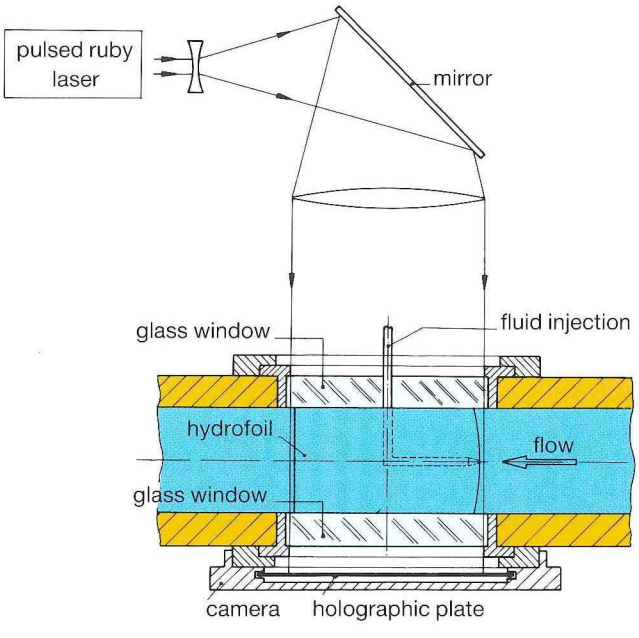
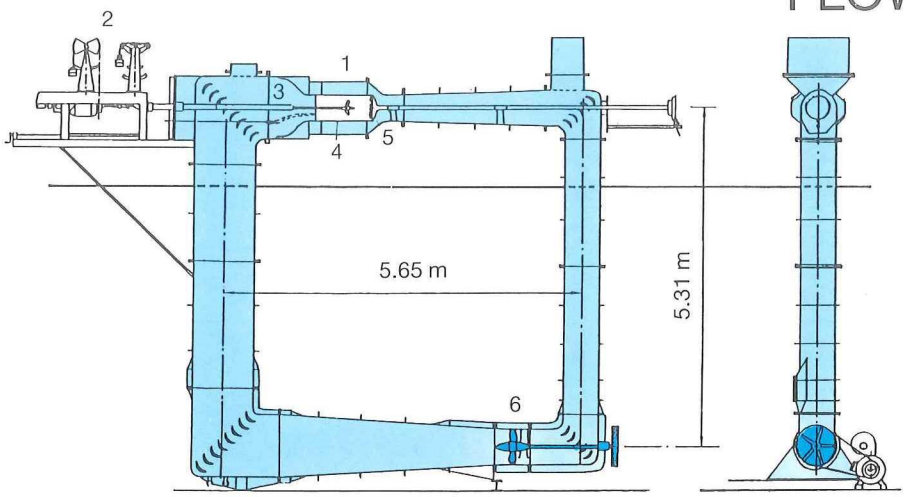
TESTS PERFORMED :
- Cavitation inception measurements.
- Holographic recordings of boundary layer flow behaviour (a), cavitation phenomena (b) and nuclei distributions (c).
- Studies on laser-induced cavities.
- Erosion measurements.
- Noise measurements.
- Luminescence measurements.

PUBLISHED DESCRIPTION :
- Witte, J.H.,
'The Ultra High-Velocity Tunnel of the NSMB',
International Shipbuilding Progress, Vol. 13, No.144,
August 1966 (NSMB Publ. No. 281).
- Van der Meulen, J.H.J.,
'A Holographic Study of Cavitation on Axisymmetric Bodies and the Influence of Polymer Additives',
NSMB Publ: No. 509, June 1976.
- Van der Meulen, J.H.J.,
'Boundary Layer and Cavitation Studies of NACA 16-012 and NACA 4412 Hydrofoils', Proc. 13th Symp. on Naval Hydrodynamics, Tokyo, Oct. 1980, pp. 195 - 219.



# CAVITATION TUNNEL WITH FLOW REGULATOR (1956) Modified 1982




1. *Test section*
2. *Thrust and torque dynamometer*
3. *Flow regulator*
4. *Slotted wall*
5. *Pitot rake*
6. *Axial flow impeller*

| | | |
|---|---|---|
| DESCRIPTION | : | Vertical plane, closed recirculating, variable speed and pressure. |
| TYPE OF DRIVE SYSTEM | : | 0.565 m Diameter fixed pitch three-bladed axial flow impeller, thyrister controlled, 22 kW, 650 rpm (impeller). |
| PROPELLER MOTOR | : | Thyrister controlled, 10 kW, 3500 rpm. |
| WORKING SECTION MAX. VELOCITY | : | 7 m/s. |
| WORKING SECTION CHARACTERISTICS | : | 0.4 m Diameter with slotted wall, length 0.8 m. |
| PRESSURE RANGE | : | 35 - 150 kPa. |
| CAVITATION NUMBER RANGE | : | $\sigma_n = 0.7 - 4$. |

| | | |
|---|---|---|
| INSTRUMENTATION | : | Dynamometers, strain gauge elements, pitot rake, strobe lights, time lapse film recorder. |
| TORQUE AND THRUST DYNAMOMETERS | : | Balance with calibration weights between motor and tunnel. |
| PROPELLER SIZE | : | Max. diameter 250 mm. |
| WAKE FIELD SIMULATION | : | Axial wake field simulated by flow regulator consisting of 152 channels with valves to be adjusted from outside tunnel. |

Maritime Research Institute Netherlands (MARIN)
Haagsteeg 2, P.O. Box 28, 6700 AA Wageningen, The Netherlands
Phone: +31/ 8370 93911, Telex: 45158 nsmb nl
Telephone copier / Telefax: +31/ 8370 93245

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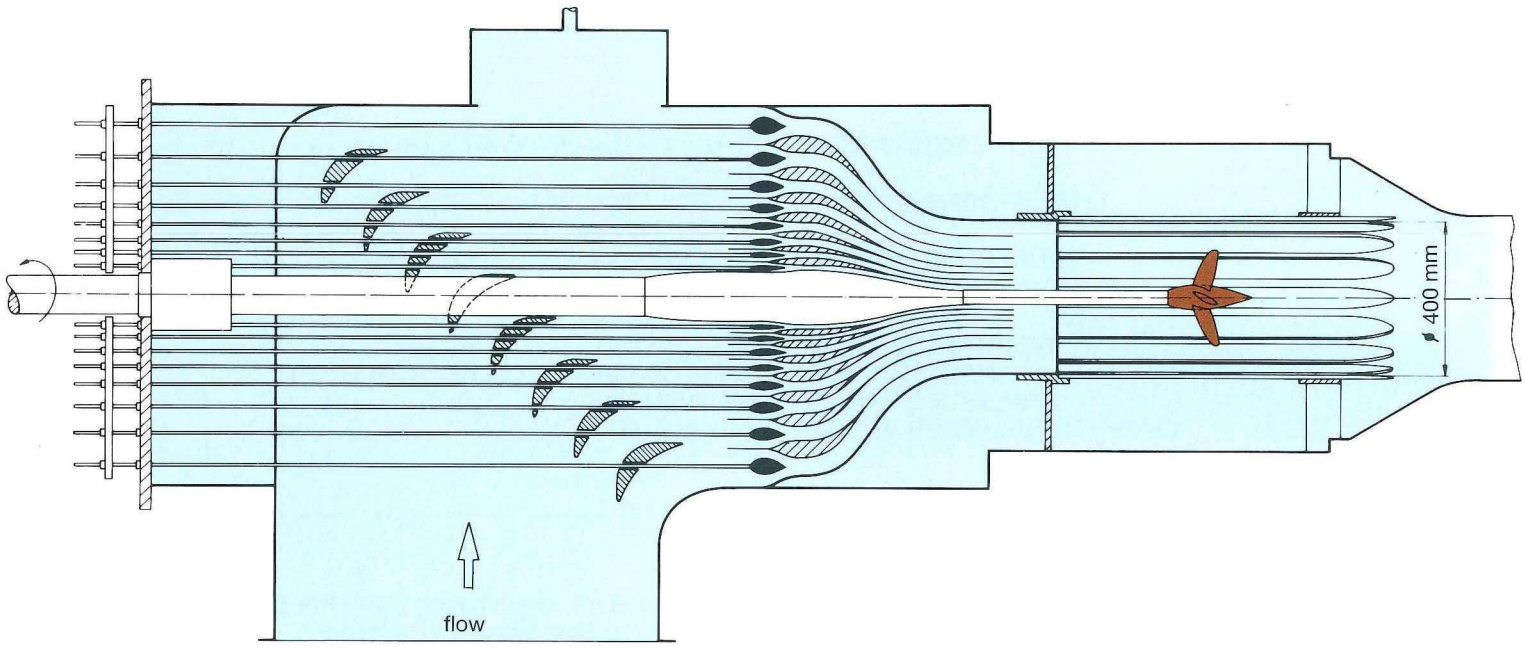
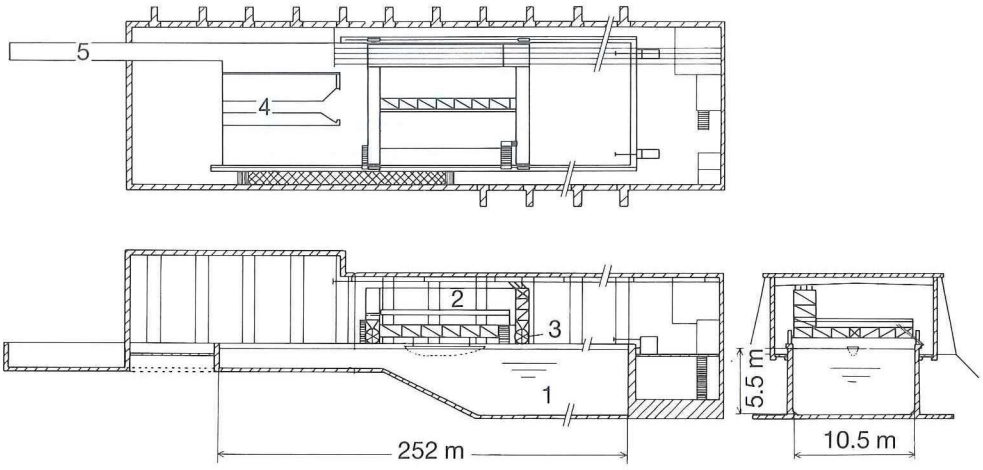
TESTS PERFORMED : - Cavitation observation tests and cavitation inception measurements with propellers in simulated axial wake field.
- Measurements of forces and torques on nozzles, rudders etc.
- Erosion tests.

PUBLISHED DESCRIPTION : 12th ITTC Proceedings, Rome, 1969.



# DEEP WATER TOWING TANK (1932)

## Modified 1951




1. *Basin*
2. *Towing carriage*
3. *Drive wheels*
4. *Harbour*
5. *Passage to workshop*

| | | |
|---|---|---|
| DIMENSIONS | : | 250 m × 10.5 m, 5.5 m deep. |
| CARRIAGE | : | Manned, motor driven, four drive wheels, four pairs of horizontal guide wheels. |
| TYPE OF DRIVE SYSTEM AND TOTAL POWER | : | Thyrister controlled power supply, 4 × 45 kW. |
| MAXIMUM CARRIAGE SPEED | : | 9 m/s. |
| OTHER CAPABILITIES | : | Vertical/horizontal PMM, wind-force dynamometer set-up. |

| | | |
|---|---|---|
| INSTRUMENTATION | : | Dynamometers with strain gauge transducers in propeller hub, wind-force dynamometer, 6-component force balance dynamometer, 5-hole pitot tube, laser doppler velocity scanner, underwater photographic and video tape systems, pressure transducers, transducer for wave cut experiments. |
| MODEL SIZE RANGE | : | 1.5 - 8.5 m. |

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Phone: +31/ 8370 93911, Telex: 45158 nsmb nl
Telephone copier / Telefax: +31/ 8370 93245

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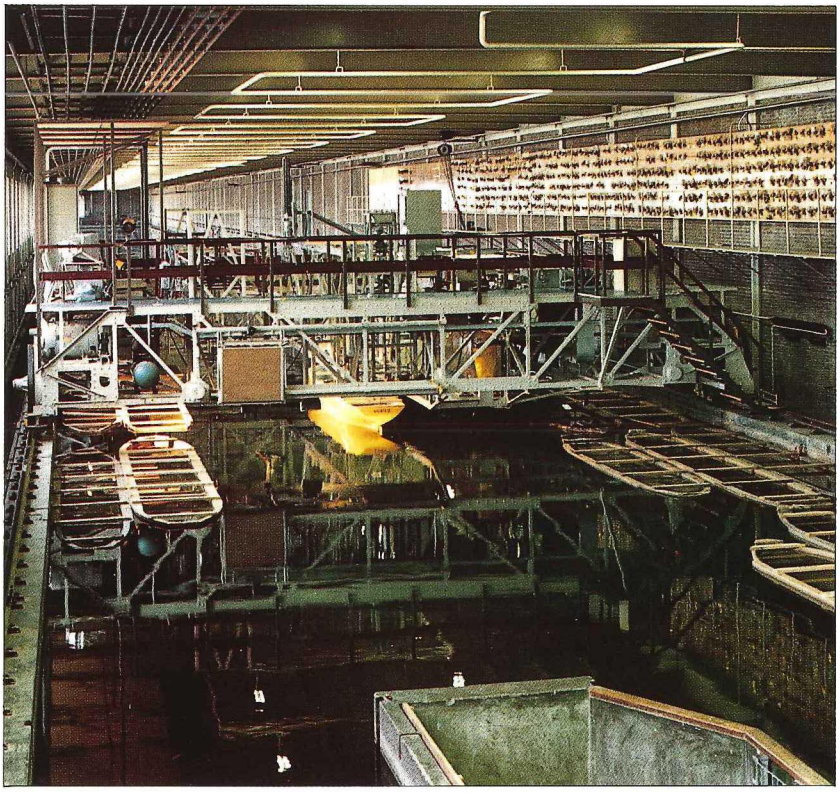
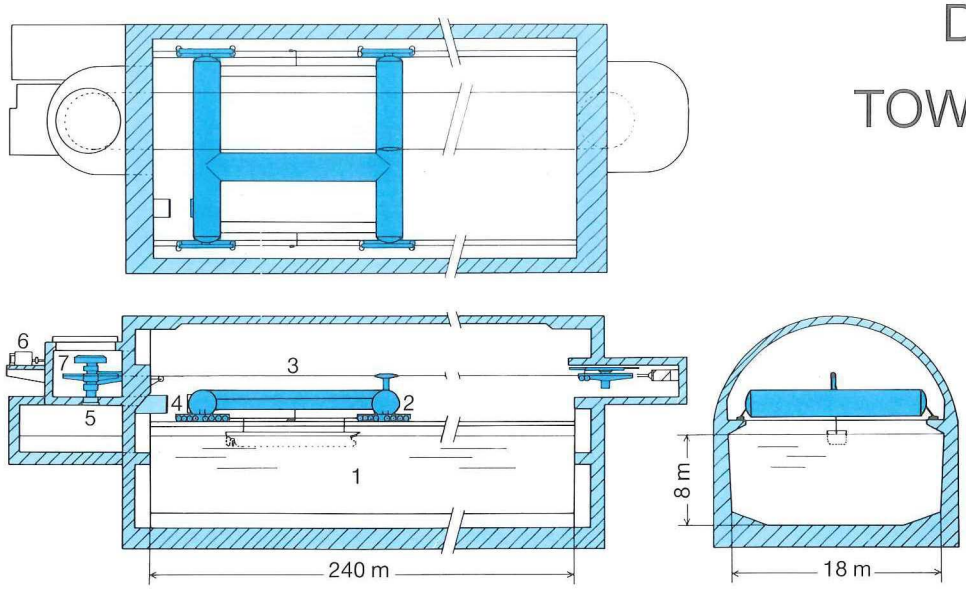
TESTS PERFORMED :
- Resistance and self-propulsion tests in calm water.
- Open water propeller/ducted propeller tests.
- 3-D wake surveys.
- Flow observation tests by paint or tufts.
- Measurement of hydrodynamic forces and moments on submerged bodies, foils etc.
- Unsteady propeller blade force measurements.
- Vertical/horizontal planar motion experiments.
- Yacht testing.
- Longitudinal wave cut experiments.
- Current force measurements.

PUBLISHED DESCRIPTION : Van Lammeren, W.P.A., Troost, L. and Koning, J.G., 'Resistance, Propulsion and Steering of Ships', Stam-Holland, 1948.



# DEPRESSURIZED TOWING TANK (1972)




1. *Basin*
2. *Towing carriage*
3. *Cable drive system*
4. *Personnel lock*
5. *Model lock*
6. *Drive motor*
7. *Reducing gear*

| | | |
|---|---|---|
| BASIN | : | Constructed of a special reinforced concrete, completely airtight, 240 m long, 8 m deep and 18 m wide. The pressure in the basin can be lowered by means of 7 vacuum pumps. The basin is provided with an airlock permitting passage of ship models to or from the basin. |
| CARRIAGE | : | Composed of cylindrical tubes of steel with a diameter of 2.5 m, 32 wheels, operated by a cable driving system. The pressure in the carriage is kept at atmospheric pressure; therefore the carriage can be manned during operation. It is equipped with a general purpose model support bridge. The carriage speed is remotely controlled by a DEC 11/44 computer housed in an airconditioned control room. |
| DRIVE SYSTEM AND TOTAL POWER | : | Thyrister controlled power supply, 410 kW. |
| MAXIMUM CARRIAGE SPEED | : | 4.25 m/s. |
| PRESSURE RANGE | : | 4 - 100 kPa. |
| OTHER CAPABILITIES | : | Horizontal PMM. |

| | | |
|---|---|---|
| INSTRUMENTATION | : | Dynamometers with strain gauge transducers in propeller hub, 6-component force balance dynamometer, 5-hole pitot tube, laser doppler velocimeter scanner, stobe lights, underwater photographic and video tape systems, pressure transducers, hydrophones. |
| MODEL SIZE RANGE | : | 5.5 - 13 m. |

Maritime Research Institute Netherlands (MARIN)
Haagsteeg 2, P.O. Box 28, 6700 AA Wageningen, The Netherlands
Phone: +31/ 8370 93911, Telex: 45158 nsmb nl
Telephone copier / Telefax: +31/ 8370 93245

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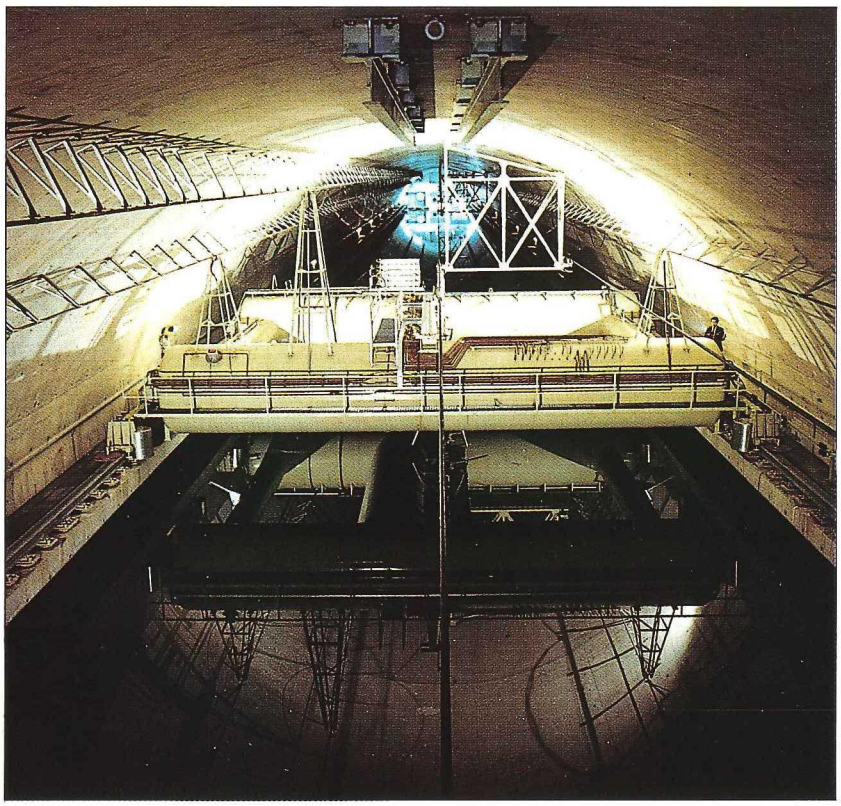
TESTS PERFORMED :

- Resistance and propulsion tests in calm water.
- Open water propeller/ducted propeller tests.
- 3-D wake surveys.
- Flow observation tests by paint or tufts.
- Measurement of hydrodynamic forces and moments on submerged bodies, foils etc.
- Unsteady propeller blade force measurements.
- Horizontal planar motion experiments.
- Propeller induced shaft force measurements.
- Pressure fluctuation measurements.
- Radiated noise measurements.
- Cavitation observation tests.
- Cavitation inception measurements.

PUBLISHED DESCRIPTION : Kuiper, G.,
'Cavitation Testing of Marine Propellers in the NSMB Depressurised Towing Tank', Conference on Cavitation, Edingburgh, Sept. 1974, pp. 203 - 215.



MARITIME RESEARCH INSTITUTE NETHERLANDS

MARIN

# Maritime Research Institute Netherlands

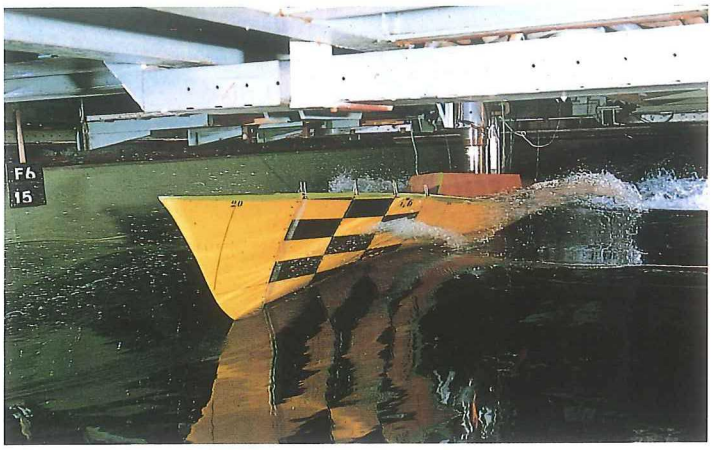
## General

The Maritime Research Institute Netherlands (MARIN) performs research and development and offers consultative assistance to the maritime industry. The maritime industry includes the shipping, shipbuilding and offshore industries and governmental and supra-national organisations. Consultative assistance mainly involves the optimization of design and operation of ships and offshore constructions from a hydrodynamic and nautical point of view. Hydrodynamic advice is given by MARIN while nautical research and training is performed by the Maritime Simulation Centre Netherlands, MSCN, a joint venture of MARIN and Delft Hydraulic Laboratories.

## History

MARIN was founded in 1929 by four Dutch shipowners and the State of The Netherlands. Research work started in 1932 in Wageningen following the completion of the first facility, a Deep Water Towing Tank for testing ship models in still water. From the very beginning, the institute was strongly oriented towards industrial services. In the first period of its existence, extending from 1930 to 1950, the industrial assignments were in most cases related to the optimization of hull forms and propulsion devices by means of model tests in the Deep Water Basin.

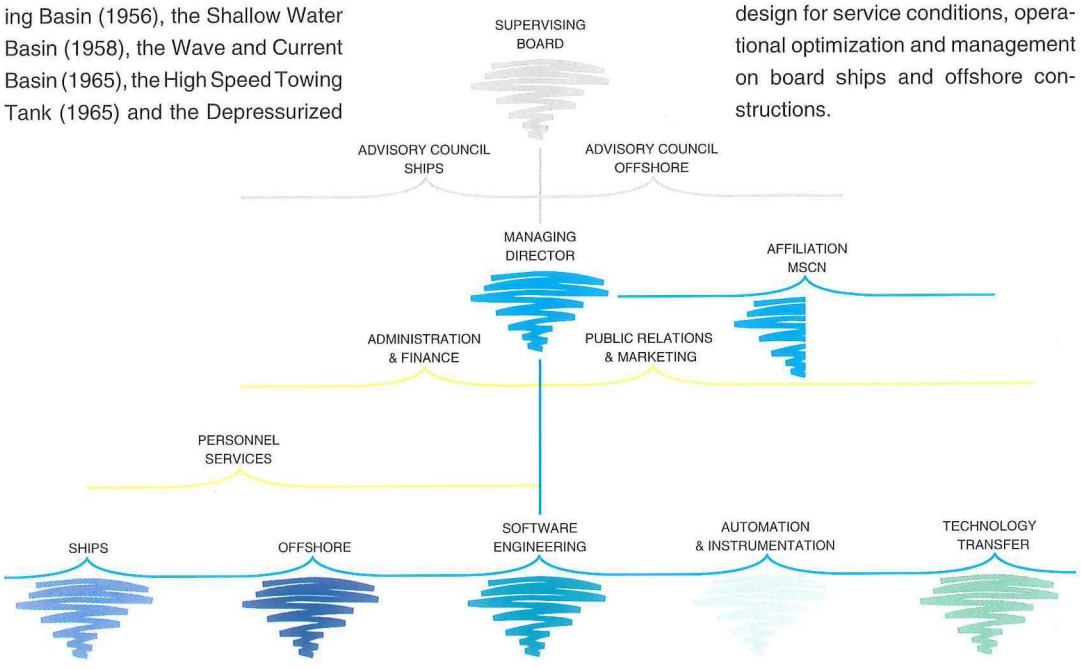
After 1950 there was a large increase in shipping and shipbuilding activities worldwide, resulting in a diversification of ship types and a rapid growth in size and speed. This period also marked the start of offshore and ocean engineering activities. In the period between 1950 and 1970 the scope of research widened to include specific items such as behaviour in a seaway, manoeuvring characteristics, shallow water effects, cavitation, hydrodynamic unsteady loads on hull and propeller and noise. In the case of offshore work, the key items were mooring, dynamic positioning and installation. To cope with the demands of the industry, a whole series of special purpose laboratories were built. These laboratories include Cavitation Tunnels (1941, 1956), the Seakeeping Basin (1956), the Shallow Water Basin (1958), the Wave and Current Basin (1965), the High Speed Towing Tank (1965) and the Depressurized Towing Tank (1970). For nautical research and training a ship manoeuvring simulator (1970) was brought into operation. In the period since 1970, the industrial services of the institute have been influenced by the use of electronic computers. Reliable computer and mathematical simulation programs are becoming available to tackle problems which were earlier impossible to crack. This approach has stimulated the demand for more advanced instrumentation and systems for detailed measurements of flow and of the behaviour of constructions. The computer programs were in the first instance developed to promote understanding of the observed phenomena and to support the model experiments.




[F820889]

A Vessel Traffic Services Simulator was built in 1985, and there has been continual upgrading of the nautical simulator ever since. This has laid the base for a more sophisticated and 'high tech' approach to problems faced by government and industry.

In many cases this approach has evolved out of close co-operation with governmental bodies and industry through co-operative research programs or joint industry projects. In the last years validated software has become both as tool and as product increasingly important in the services offered by the institute. New areas of interest are computer-aided design, design for service conditions, operational optimization and management on board ships and offshore constructions.



MARITIME RESEARCH INSTITUTE NETHERLANDS

MARIN

**MARIN**
**P.O. Box 28**
**6700 AA Wageningen**
**The Netherlands**

**Telephone +31 8370 93911**
**Telex 45148 nsmb nl**
**Telefax +31 8370 93245**

## Main activities

The main activities of the institute categorized by market segment are:

- *Ships*

Resistance, propulsion, cavitation and noise, manoeuvring and seakeeping.

- *Offshore*

Behaviour of and loads on floating and fixed structures in waves, wind and current, dynamic positioning, mooring and installation.

- *Software Engineering*

Development of software both as tool and as product, measurements on board ships and offshore structures.

- *Automation and Instrumentation*

Development of measuring and monitoring systems for both model and full-scale applications.

- *Technology Transfer*

Assisting in the development of new test facilities and their instrumentation for third parties and in data acquisition systems, training and education.

## Staff and organisation

An experienced staff covering a broad range of disciplines enables MARIN to render services to the maritime industry at a high scientific level.

At present, the staff of MARIN consists of about 200 persons, half of whom are educated at tertiary level.

MARIN is an independent foundation operating on a non-profit base. No particular relationships exist with any other organisation and hence all customers are accorded the same priority and services. Results of investigations carried out by MARIN remain the sole property of the client.
The total turnover amounts to about Dfl. 35 million per year.

## Location

MARIN's head office is in Wageningen, The Netherlands. Wageningen is a small town with a population of about 30,000. It is located in the central part of the Netherlands, near the city of Arnhem, on the banks of the river Rhine.
One of MARIN's large facilities, the Depressurized Towing Tank, is situated in Ede, which is about 7 km from Wageningen. Both places are easily accessible by train or car. Travel time from Schiphol (Amsterdam) Airport is about 1 hour.

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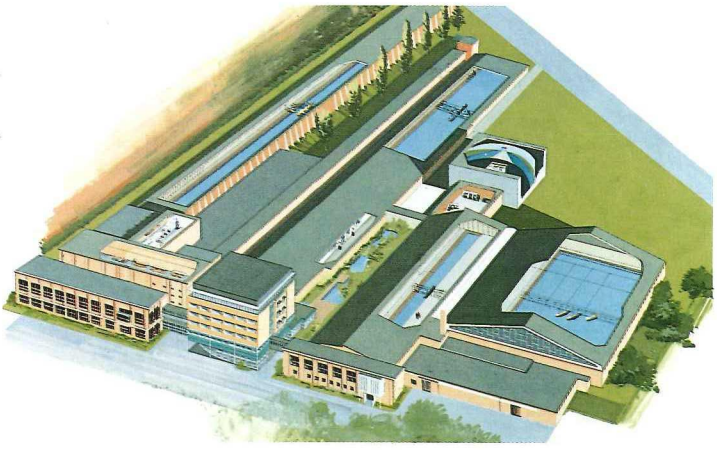


## MARIN publications

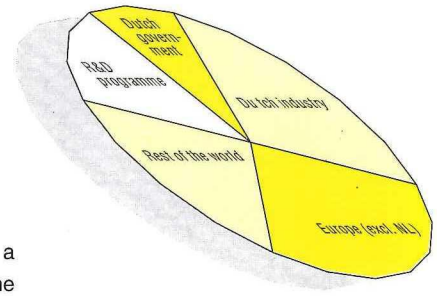
*Quarterly Report*
MARIN Report appears four times a year and gives information about the many aspects of MARIN's activities. It is sent free of charge on request to interested parties.

*Publications*
MARIN publications bring the results of general research into the public domain. A list of publications is available and updates of the list are regularly published in MARIN Report. These publications are obtainable on request.

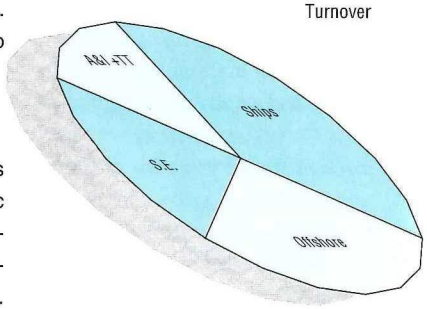
*Reports*
MARIN reports contain the results of commissioned work. These reports remain the sole property of the client and will only be made available to other parties with the written permission of the client.

## Quick fax services

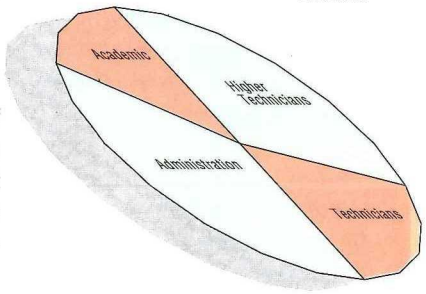
To answer questions in the design stage of ships and offshore constructions, MARIN has introduced Quick Fax Services. Straightforward questions and problems are dealt with by telefax within 24 hours.




Turnover




Activities




Staff

## Addresses

*Postal address*
MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands
Telephone: +31 8370 93911
Telefax: +31 8370 93245
Telex: 45148 NSMB NL

*Visiting address*
MARIN
2 Haagsteeg
6708 PM Wageningen
The Netherlands

*Address of MARIN facilities in Ede*
MARIN
16 Galvanistraat
6716 AE Ede
The Netherlands

# Ship Research

## General

The activities of the Ship Research Department cover a wide range of services related to the optimization of the design, operability and safety of ships. For these services, use is made of advanced computational methods and model testing techniques. The main areas are resistance, propulsive performance, cavitation, propeller-induced noise and vibration excitation, manoeuvring and seakeeping.

Special test facilities are available for testing high-speed craft and for tests in shallow water, both in combination with waves. In the area of seakeeping there is close cooperation with specialists from the Offshore Research Department. The Ship Research Department has an experienced staff of almost 60 people available to support both applied research and development for industrial and multi-client sponsored projects, as well as for fundamental research.

The Ship Research Department includes the Deep Water Towing Tank, three Cavitation Tunnels and the Depressurized Towing Tank, as well as the Drawing Office and the Ship Model Workshop. Tests are also conducted in the facilities included in the Offshore Research Department. For full-scale measurements use is made of the services of the Trials and Monitoring Group of the Software Engineering Department. The production of propeller models and special constructions is the responsibility of the Automation & Instrumentation Department.

## Services and products

- Advice and assistance in the design of ship hull forms, appendages and propulsors.
- Testing of ship and propulsor models for resistance, propulsive performance, cavitation, noise and vibration excitation, manoeuvring and seakeeping.
- Computation of the flow around ship hulls, both viscous and non-viscous.
- Computational predictions of propulsive performance, propeller-induced vibration excitation, cavitation, manoeuvring and seakeeping behaviour.
- Multi-client sponsored research and development.
- Troubleshooting.

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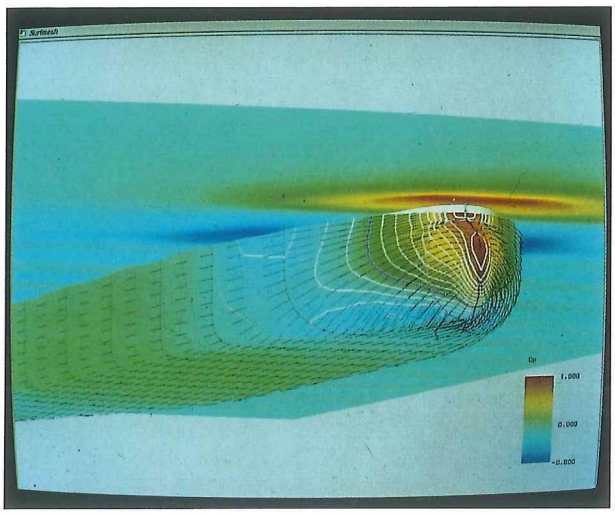
[F913939]



## Computational facilities

- Software for geometry handling of ships and propellers, coupled to the model manufacture process and to ship and propeller performance analysis software.
- Computational Fluid Dynamics (CFD) codes for viscous and non-viscous ship hull flow, propeller analysis, seakeeping and propeller or thruster-hull interaction.
- Lifting surface codes and related software for propeller design and analysis, advanced propeller blade section design, cavitation and propeller-induced vibration excitation.
- Semi-empirical codes for the prediction of the propulsive performance of various types of displacement ships, planing craft, catamarans, hydrofoil craft, surface effect ships and waterjets, and for the prediction of manoeuvring characteristics.

Details of the software are provided in separate leaflets.

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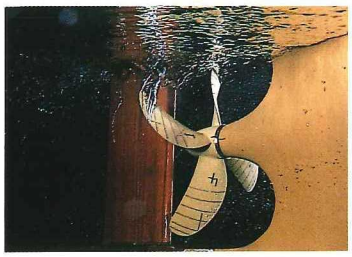
MARIN

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands

Telephone +31 8370 93911
Telex 45148 nsmb nl
Telefax +31 8370 93245



[F12-85VT]

## Model test facilities

- *Deep Water Towing Tank*

Dimensions: 252 x 10.5 x 5.5 m.
Resistance, propulsion, flow, wake, and open water tests.

- *Cavitation Tunnel No. 1*

Test section 0.9 x 0.9 m, rectangular.
Wake simulation by means of dummy models.
Cavitation tests with propeller models and hydrofoils.

- *Cavitation Tunnel No. 2*

Test section 0.4 m, circular.
Axial wake simulation by means of flow regulator.
Cavitation tests with propeller models.

- *Cavitation Tunnel No. 3*

Test section 0.04 m, circular.
Fundamental cavitation studies on hydrofoils and other fixed bodies.

- *Depressurized Towing Tank*

Dimensions: 240 x 18 x 8 m.
Minimum air pressure: about 4 kPa.
Resistance, propulsion, flow, wake, and open water tests under atmospheric and scaled air pressure.
Cavitation on propellers, ship hulls and appendages; radiated noise, hull-pressure fluctuations, dynamic shaft forces, propeller blade stresses, blade spindle torques etc. under scaled air pressure.

Transportable 3-dimensional Laser-Doppler Velocimetry (LDV) equipment for use in Deep Water and Depressurized Towing Tanks and in the Cavitation Tunnels.
Transportable Large Stroke Hydraulic Oscillator for Planar Motion Mechanism (PMM) tests in the Deep Water and Depressurized Towing Tanks.

Details of these facilities are provided in separate leaflets.

## General Developments

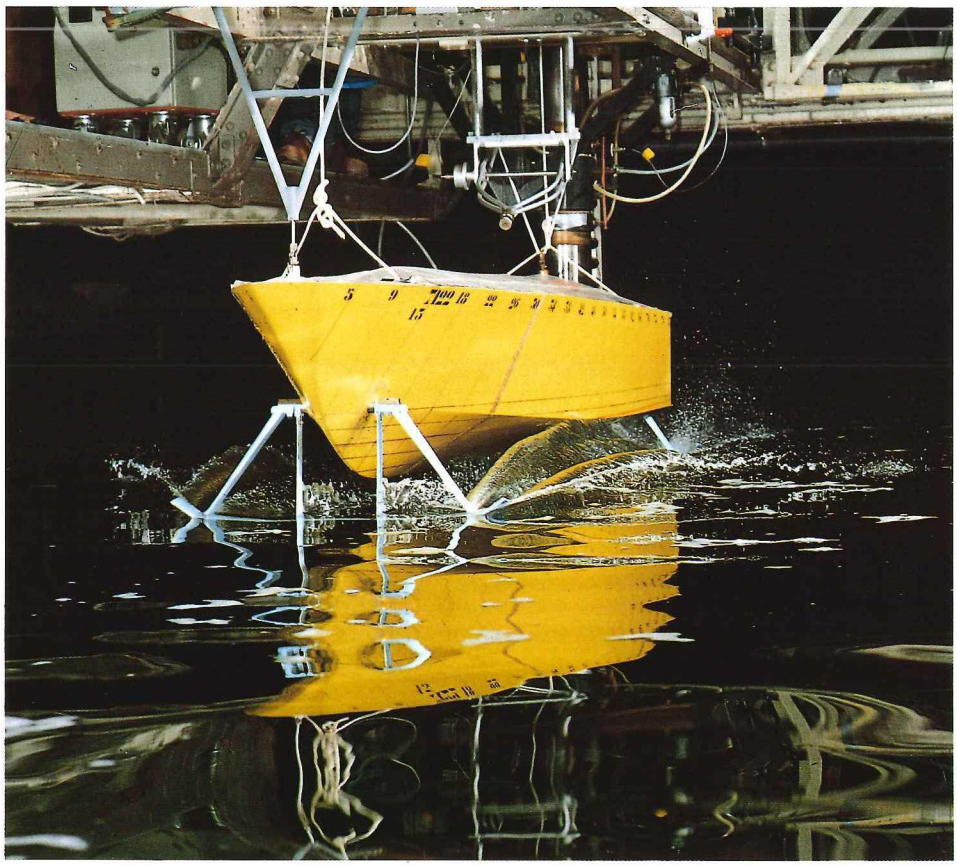
The aim of the Ship Research Department is to contribute to the development of cost-effective, fuel-efficient, safe and liveable ships. To this end, extensive and rapidly increasing use is made of computational methods for rapid, low-cost optimization of ship hull forms and propulsors. The final performance predictions are made on the basis of model tests, which can be limited in scope when optimum use is made of computational methods in the initial stages of projects. The nature of model tests is developing towards the use of more complex measuring techniques. The need for such techniques is driven by the necessity to verify the computational methods in their development stages, and by the increased interest in operational aspects of ships and special types of vessels and propulsors. This concerns in particular catamarans, hydrofoil craft, surface effect ships (SES), large sailing yachts, SWATH vessels, waterjets, surface piercing propellers, contra-rotating propellers etc., all areas in which MARIN has built up considerable experience.

## Organisation and contacts

The Ship Research Department consists of four sections:

- Project Management
- Data Analysis
- Model Testing
- Ship Model Production.

[F900481]



# Offshore Research

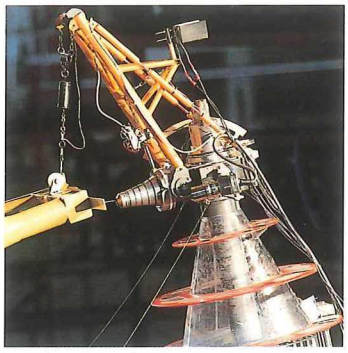
**Why Offshore Research?**

Designers and operators of ocean-going ships or offshore structures are inevitably faced with the influence of weather on in-service performance. Behaviour in waves, wind and current strongly affects the technical and economic feasibility of ship and platform concepts and offshore operations.

To assist in the evaluation and optimization of a design for a typical ocean environment, the Offshore Research Department provides advisory services to clients in the form of computations and model tests, followed by feasibility or operability analyses.

These services are supported by long-term applied research, as well as the development of new numerical tools and experimental techniques.

[F906190]



[F893967]

**Experience...**

*Worldwide offshore operations*

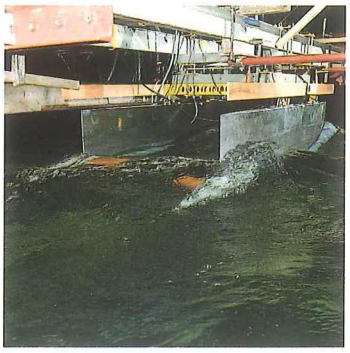
- Floating production and storage concepts, single-point moorings, DP systems, semi-submersibles, TLPs, gravity base and jacket platforms.
- Towing, installation and operation problems.
- Heavy lift operations, special transports and offloading.
- Tanker berthing and jetty mooring.
- Offshore support and dredging.

[F894338]

*Seakeeping*

- Comfort of ferries, cruise liners and yachts; performance of fin stabilizers.
- Safety of hatchless container ships; VLCCs.
- Supply, salvage and oil-skimming vessels.
- High-speed displacement ships, patrol boats.
- Performance of catamarans (conventional and wave-piercing), hydrofoils, SWATH and SES vessels.
- Required service margin, voluntary and involuntary speed loss.

[F912045]



**Expertise...**

- Wave-induced excitation and response of ships and floating structures; linear and higher order approaches, mathematical modelling.
- Dynamics of anchor lines, flexible risers and bow hawsers; mooring analysis; fluid-structure interaction.
- Wave kinematics, wave-current interaction, current loads, slamming, dynamic wind loads.
- Dynamic positioning, thruster allocation and performance.
- Large amplitude ship motions and safety against capsizing; fin stabilizers; course keeping in waves.
- Operability analysis in frequency and time domain.
- Sophisticated scale models and instrumentation.

MARITIME RESEARCH INSTITUTE NETHERLANDS

MARIN

P.O. Box 28
6700 AA Wageningen
The Netherlands

Telephone +31 8370 93911
Telex 45148 nsmb nl
Telefax +31 8370 93245

## ... and the Experts

All projects are managed by highly qualified engineers, with both a theoretical and a practical knowledge of naval architecture and offshore engineering. Their specialisations comprise hydrodynamics, mathematics, statistics and physics. They are assisted by personnel with extensive experience in model manufacturing and testing, instrumentation, mathematical modelling and data analysis. There is close cooperation with the Ship Research Department in relation to combined powering and seakeeping analysis, and with the Software Engineering Department on the use of computer programs.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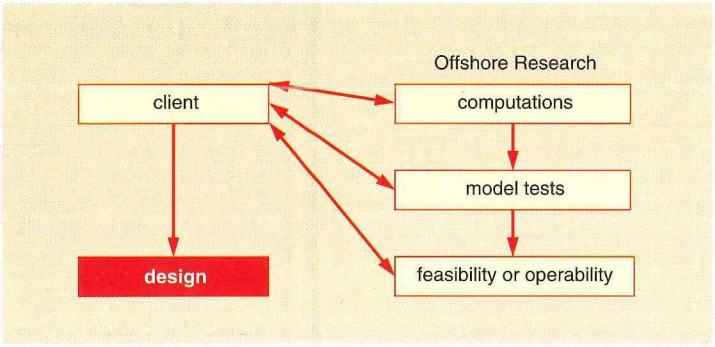


## Laboratories

Besides numerous facilities for computational purposes, four large basins with wave generating capabilities are available for model testing:

- Wave and Current Basin
(60 x 40 x 2 m), including a pit with a total depth of 6.5 m
- Seakeeping Basin
(100 x 25 x 2.5 m), including a pit with a total depth of 6.0 m
- High Speed Basin
(200 x 4 x 3.7 m)
- Shallow Water Basin
(220 x 15.8 x 1.15 m)

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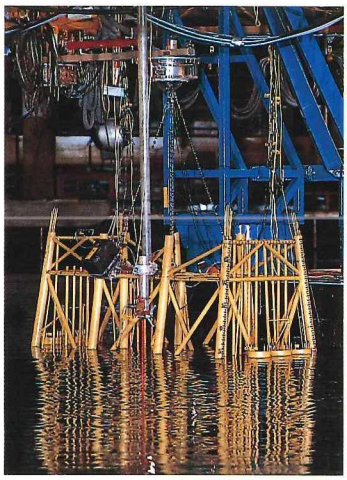

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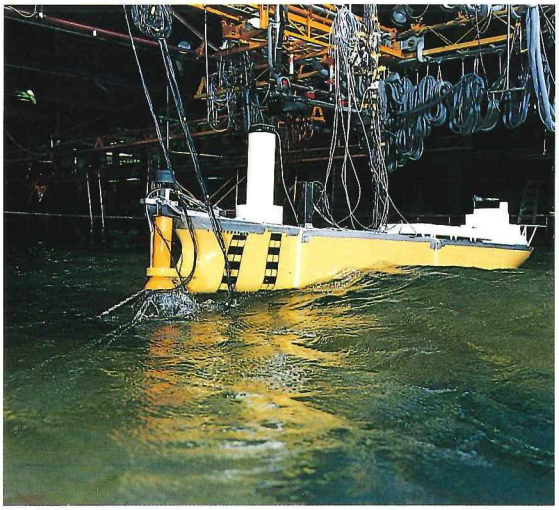

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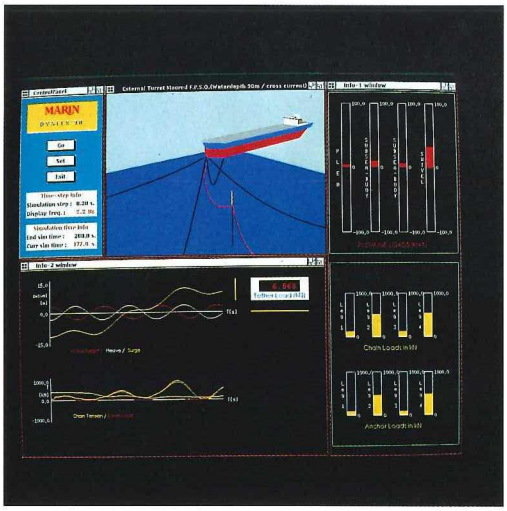


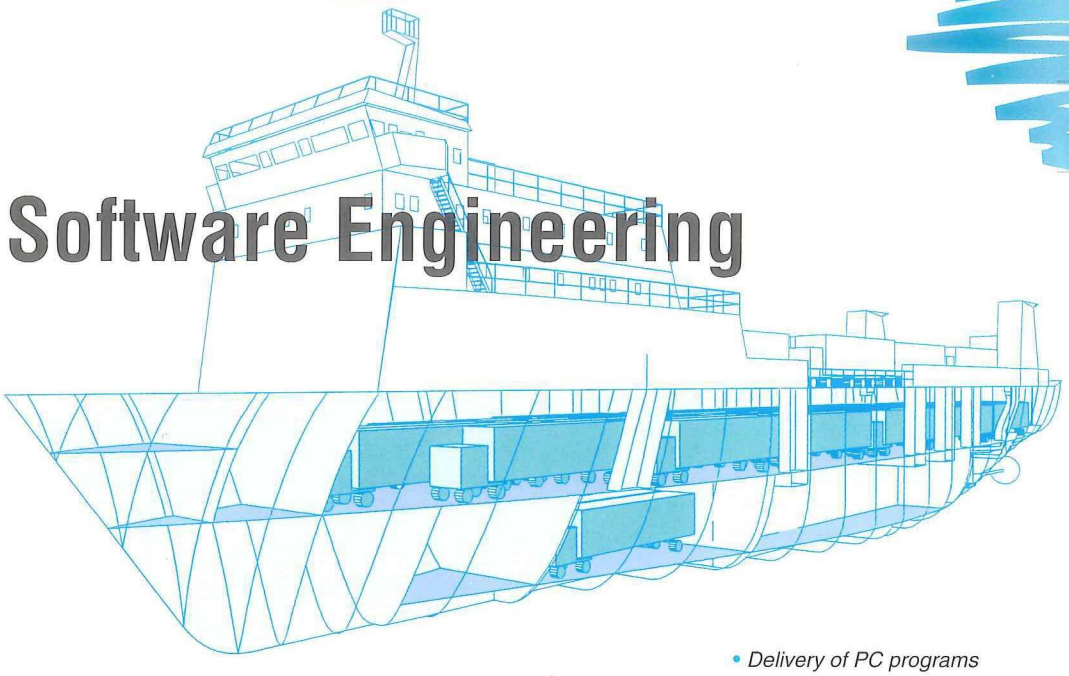
## R&D Backup

To improve their expertise and knowledge in areas useful to industry, all project engineers are also involved with on-going research activities:

- development of theoretical and numerical models;
- model testing, database extensions, experimental and data analysis techniques.

In addition, emphasis is placed on joint industry projects and on cooperation with universities. Results are frequently presented at international conferences and in various journals.

# Software Engineering



## General

MARIN's Software Engineering Department develops, delivers and supports advanced hydrodynamic application software for the shipping, shipbuilding and offshore industries. The decentralised availability of computers has drastically increased the opportunity of performing predictions and calculations. This has prompted the development of practical design and engineering programs embodying MARIN's know-how. The powerful computers now available also enable numerical solution of complex problems in the fields of hydromechanics, system dynamics and structural response.
In these cases advanced and verified mathematical models form the basis for the application software.

MARIN has vast experience in these fields and the Software Engineering Department takes advantage of the existing data, knowledge and facilities in the development of the computer programs.
This experience can also be used for dedicated software developed according to client specifications.

In all cases: the emphasis is placed on the technical accuracy and reliability of the software. The Software Engineering Department develops on a fixed quality, price and time basis. According to the QA-system, a software development project comprises functional and technical design, mathematical modelling with verification, coding, testing, validation, documentation and implementation.
For verification and validation, special purpose model tests and measurements at sea (see separate leaflet) are normally carried out. Delivery, installation, training, maintenance and support of the software are all part of the package. Use of system and programming standards guarantees implementation on a wide variety of computer systems.

## Services

- *Shared research and development*

Development of mathematical models and verification by measurement campaigns is expensive. Since software can be delivered to multiple clients at marginal cost, joint development is normally of benefit to all parties.

- *Tailor-made software*

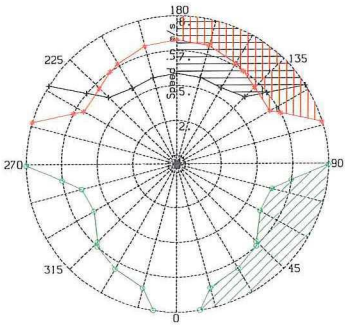
Custom-built software, specialised versions or extensions can all be developed to the client's specifications.

- *Verification and validation of software*

Accuracy and reliability of technical application software is of prime importance. For this reason, all MARIN software is not only numerically tested but also compared with model tests and full-scale measurements.

- *Delivery of PC programs*

For practical local use by designers and engineers, many of the existing programs are issued for use on Personal Computers.




- *Licences on advanced engineering packages*

Large analysis packages are made available through a licencing agreement. This procedure guarantees support, maintenance and supply of updates.

- *Installation and training*

MARIN assists in software implementation and also offers dedicated training of personnel.

- *Maintenance and support*

Computer hardware and software are developing fast. The MARIN organisation guarantees continuity in the software it delivers.

The Software Engineering Department is also responsible for full-scale measurements at sea on board ships and offshore platforms.
Further information on the Trials & Monitoring Group is given in a separate factsheet.

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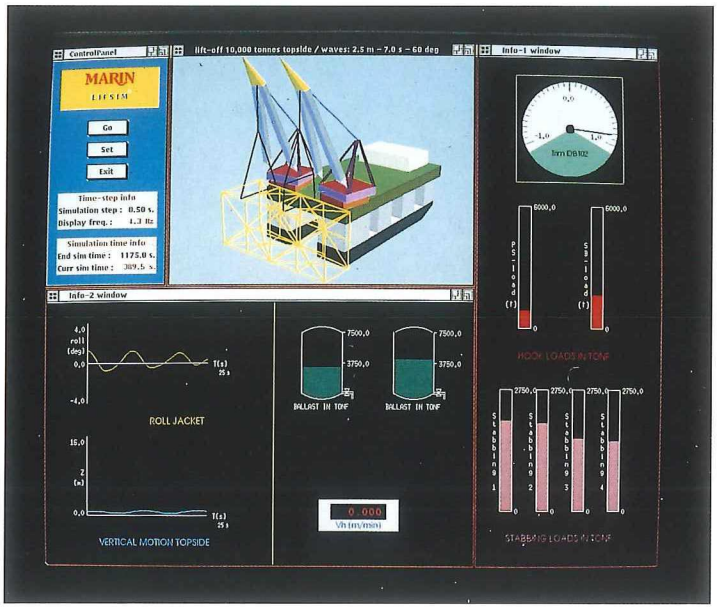


MARITIME RESEARCH INSTITUTE NETHERLANDS

MARIN

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands

Telephone +31 8370 93911
Telex 45148 nsmb nl
Telefax +31 8370 93245

## Products

A wide range of software packages are described in separate 'software documentation sheets'. The following areas are covered:

• *Hull form and CAD*

Design and computational hydrodynamics start with geometry definition. For ship design the MARIN CAD package comprises basic design, lines fairing but also a large set of application programs for hydrodynamic analysis.

• *Computational fluid dynamics*

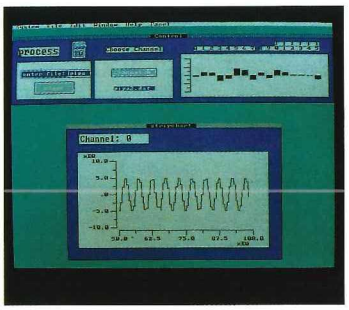
Potential-theory based programs such as DIFFRAC are used for the analysis of wave induced forces and motions. Panel methods such as DAWSON are used for flow and wave resistance. Navier-Stokes solvers such as PARNASSOS are now becoming available for practical applications.

• *Powering*

Powering prediction programs have been developed for various ship types. These predictions can be based on statistics derived from numerous model testresults available at MARIN, or on state-of-the-art calculations using accurate mathematical models and computational fluid dynamic methods.

• *Propeller design and analysis*

Design programs are available based on the famous Wageningen B- and Ka-series. Potential theory is used in various degrees of complexity and accuracy to analyse propellers.
The range includes programs for blade section design, cavitation and strength analysis. Dedicated programs have been developed for special propulsors such as thrusters and waterjets.

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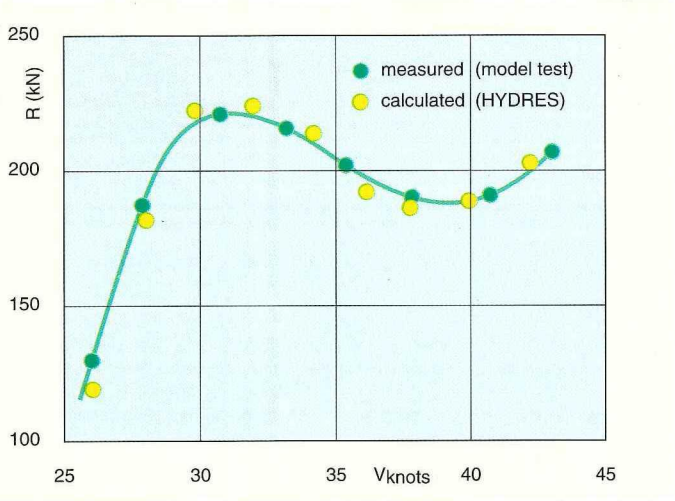
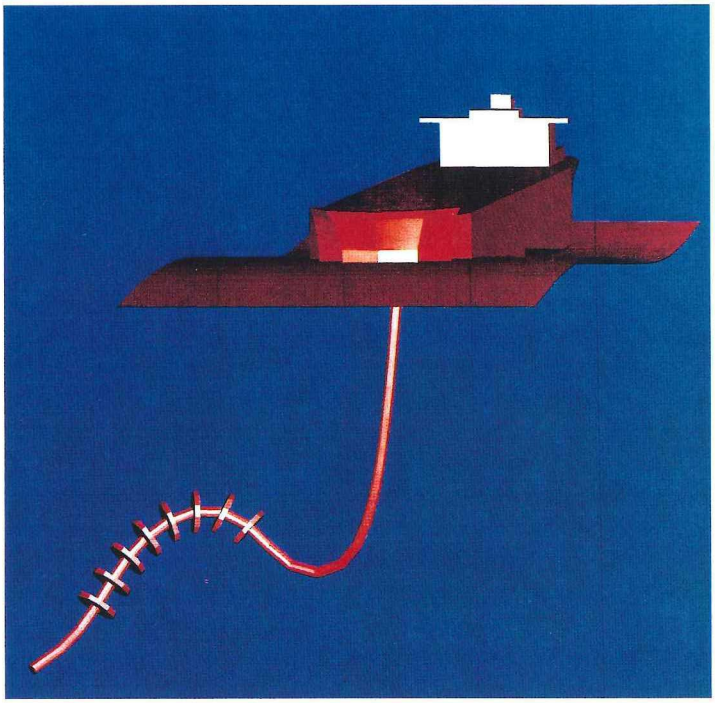
***Comparison between measured and calculated resistance of a 250 ton hydrofoil craft.***



[R901876]

• *Seakeeping, manoeuvring and ultimate stability*

Seakeeping software not only includes linear 2-D and 3-D programs for motions, added resistance and bending moments, but also complete workability analyses for the specific mission profile and area of operation. Non-linear large amplitude simulation models are available for the analysis of broaching and ultimate stability. Manoeuvrability capacities may be assessed at an early design stage.

• *Advanced vessels*

Much effort has been put into research on advanced craft such as (semi-)planing boats, catamarans, hydrofoils, frigates and submarines. Such vessels generally require an integrated approach to the analysis and optimization of resistance, propulsion, motions and control actuators.

• *Wave, wind and current loads*

Accurate predictions of the environmental excitation loads on ships, semi-submersibles and other offshore structures measurements on board ships and platforms special systems are available

• *Dynamic behavior of offshore structures*

Dedicated software has been developed for the simulation of moored and dynamic positioned vessels, heavy lift operations and flexible risers.

## Information

A 'software documentation sheet' for each software package is available on request. The Software Engineering Department will be glad to discuss the alternatives available to solve your specific problems.

# Trials & Monitoring

## General

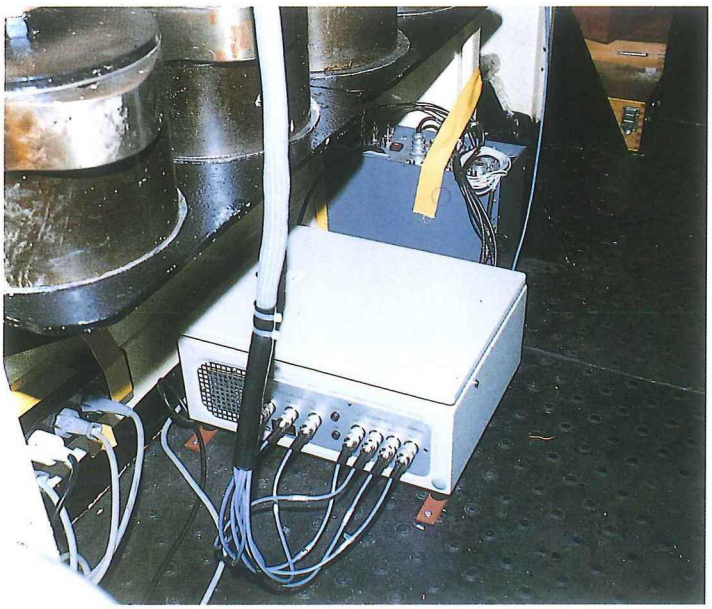
Within MARIN the Trials & Monitoring Group is responsible for measurements at sea, on board ships and offshore platforms. The role of such measurements is of growing importance from design, delivery and operational points of view.

In the design and engineering phases of vessels and offshore structures, increasing use is being made of advanced computer programs for the prediction of e.g. resistance, wave induced motions and anchoring loads. The evaluation of such computer programs with respect to applicability and accuracy requires comparisons with measured data. Measurement campaigns may also provide valuable information on actual in-service behaviour and thus on design criteria.

Nowadays, contract specifications for delivery of ships and platforms not only comprise speed and power but also manoeuvring and position keeping capabilities as well as seakeeping behaviour. Measurements during the sea trials of the vessel are needed to evaluate its performance on each of these aspects. Noise and vibration control is also an area of concern.

Continuous monitoring of the aspects outlined above is often efficient for specific operations such as heavy transport, installation, or offshore production platforms. This information is effective in controling and optimizing the operation, as well as for lifetime control (e.g. fatigue).

Measurements at sea require sophisticated and reliable equipment comprising: sensitive sensors; data acquisition, transport, reduction and storage. To reduce high labourcosts, attention is increasingly focused on automatic measurements and on board analysis.



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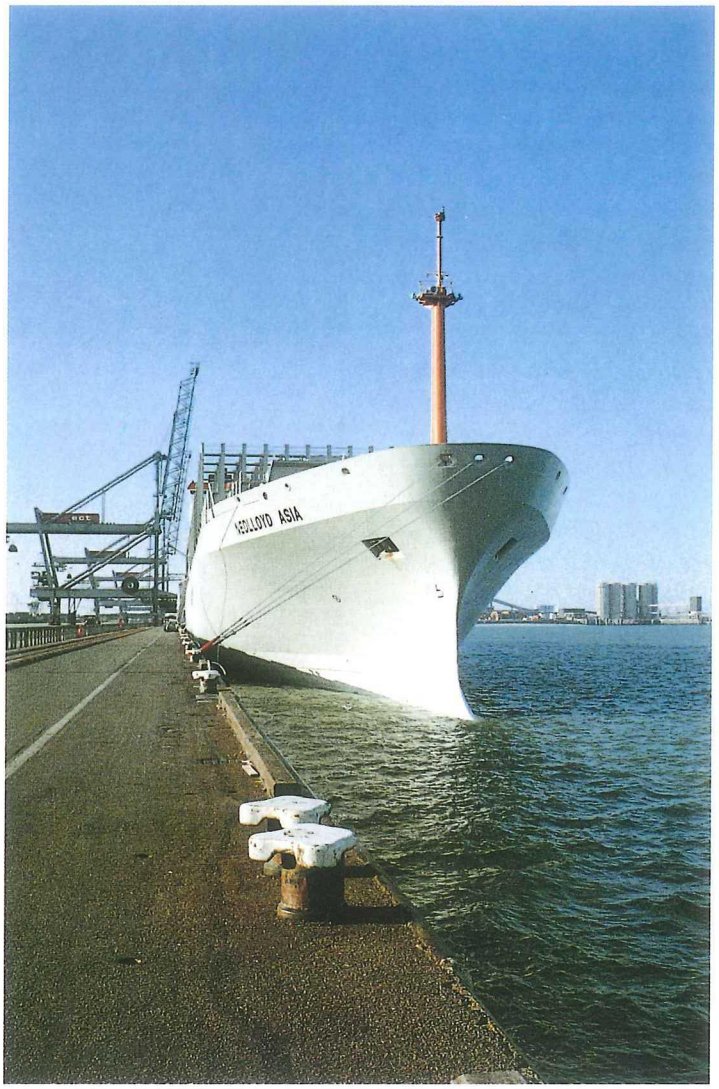



[F920356]

In many cases, measurements on board are followed by in-depth interpretation of the results. For this purpose, data analysis procedures, computational prediction tools and an understanding of the physical phenomena are all indispensable.

MARIN offers more than 60 years' expertise in hydrodynamics, measurements and evaluation. Together with present-day sensors, measurement computers and analysis software, a strong combination can be offered in fieldwork.

## Services

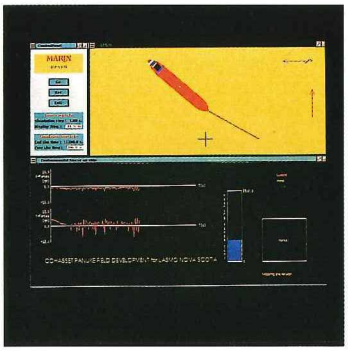
The T&M Group operates advanced measurement systems ranging from compact motion sensors to Laser Doppler Anemometers.

Wave, wind and current climate is recorded using existing networks, satellite information or dedicated equipment.

Some examples of regular services are:

- Contract sea trial measurements for powering, manoeuvring and seakeeping.
- Noise and vibration measurements.
- Propeller Quality Control.
- Cavitation observation.
- Manoeuvring, crabbing and DP-performance.
- Bollard pull and tow force.
- Structural stress monitoring.
- Platform installation monitoring.
- Wave, wind and current measurements.
- Platform motion measurements.
- Anchoring and mooring loads.

This work is normally conducted on behalf of the owner, yard or operating company. Attendance and observation of sea trials is also included in the service.



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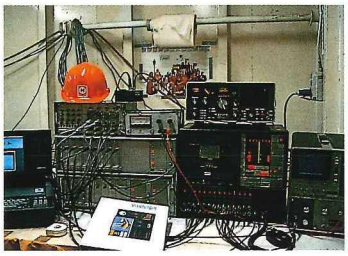

[F913428]

## Products

The services listed above include measurements, data storage and retrieval, analysis and evaluation. The result of all these services is a high quality report of the results together with discussion and recommendations.

MARIN also offers detailed correlations of the measured data with computer model predictions and model test results.

Present-day software enables efficient correlations with full-scale results. In many cases, such evaluations have proved to provide both insight and solutions.

## Organisation

The Trials & Monitoring Group is part of the Software Engineering Department.

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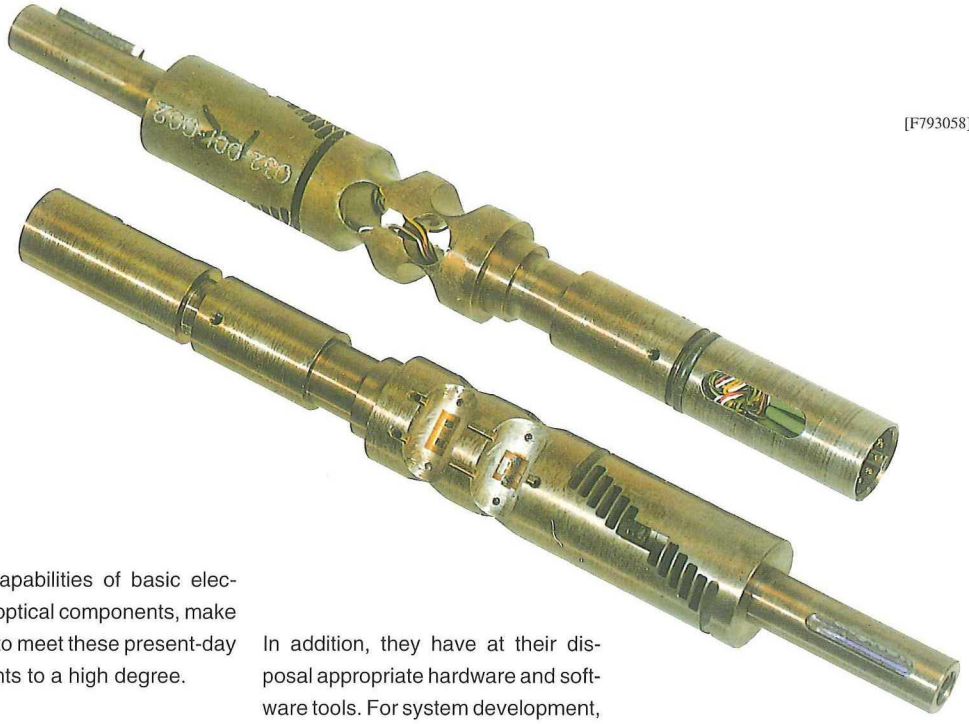
# Automation and Instrumentation



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## General

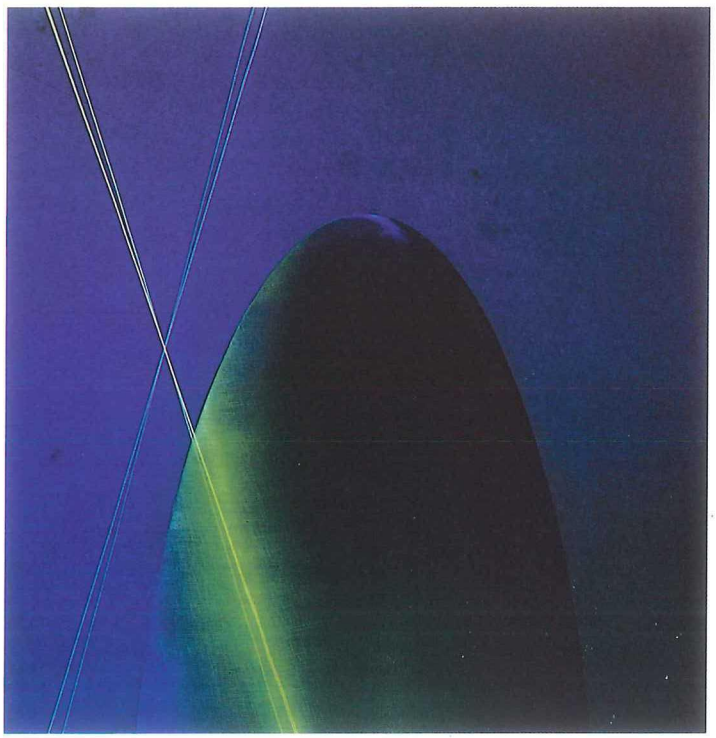
The activities of the Automation and Instrumentation (A&I) Department encompass the following main issues:

- measurement systems;
- propeller model manufacturing;
- computer facilities.

The A&I Department is heavily involved in keeping the experimental and computer facilities of MARIN up-to-date and in good operational condition.

In recent years the experiments, either with scale-models in the laboratory or at full scale at sea, have shown increasing variety and complexity. Moreover, there is an increasing demand for higher accuracy, more flexibility and improved efficiency. The extensive experience at MARIN in developing advanced measuring systems, combined with the ever-increasing capabilities of basic electronic and optical components, make it possible to meet these present-day requirements to a high degree.

To perform their tasks, the staff of the A&I Department have a thorough basic and practical knowledge of disciplines such as electronics, optics and computer techniques.



[F881109]

In addition, they have at their disposal appropriate hardware and software tools. For system development, modern structured design methods are used as part of a QA-system.

## Services

The activities of the A&I Department are focused, in the first instance, on the core business of MARIN, and hence on hydrodynamic research. However, services are also rendered to third parties, usually through the Technology Transfer project group or one of the market-oriented departments. The services to third parties comprise:

- *Delivery of hardware*

This concerns products that are manufactured using special machines, skills or knowledge available at MARIN. As a rule, MARIN does not mediate with regard to products that can be bought on e.g. the instrument market.

- *Delivery of measuring systems*

Several specialized systems with a proven record of reliability in the MARIN laboratories are also available to third parties.

- *Delivery of software packages*

This item particularly concerns computer programs needed to perform and analyse measurements in hydrodynamic laboratories.

The software is usually derived from programs developed for in-house use.

- *Training*

The A&I Department offers dedicated training directed at the operating procedures necessary to perform experiments and to use computers in a hydrodynamic laboratory.

- *Assistance in experiments*

Such assistance may concern e.g. the execution of experiments with flow measuring systems based on Laser-Doppler Anemometry, either in the laboratory or at sea.

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MARIN

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands

Telephone +31 8370 93911
Telex 45148 nsmb nl
Telefax +31 8370 93245

## Products

A selection of products offered for sale is listed below.

• *Force transducers*

The design, manufacture and calibration of one-component and multi-component force transducers for underwater use is a speciality of MARIN. Such transducers are also available to third parties.

• *Propeller models*

The procedure for the manufacture of propeller models has been improved. The resulting increase in production capacity will enable MARIN to produce more propeller models for third parties.

• *Propeller-blade-edge microscope*

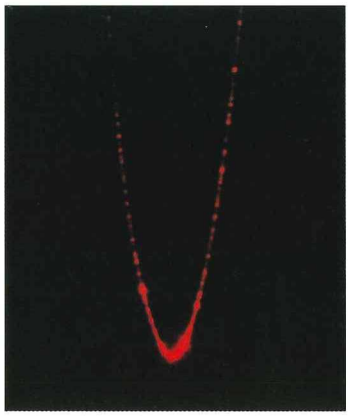
This specialized instrument produces and combines enlarged images of the desired and actual section shape at selected places along the edge of a blade. The instrument is indispensable for finishing propeller blade edges within narrow tolerances especially such as those as required for cavitation observation tests.

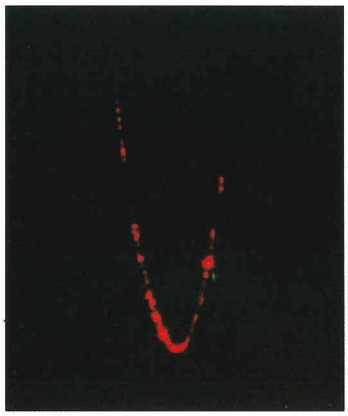
• *Wave-height probe*

The heart of this instrument is a servo controlled needle that follows the water surface up to high frequencies. The vertical position of the needle is measured.

• *Model-position-measuring (MPM) system*

This instrument is capable of measuring the values of all six degrees of freedom of a moving and oscillating object simultaneously without any mechanical contact. The data are presented in real time.





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• *Data-acquisition software*

This software initiates and controls measurements regularly carried out in laboratories like MARIN. The software is interactive and menu-structured with options for various types of measurements.

• *Data-analysis software*

Several software packages are available for the analysis of measured data. They may contain modules for preprocessing (e.g. filtering), general statistical and spectral analysis, special analysis and postprocessing.

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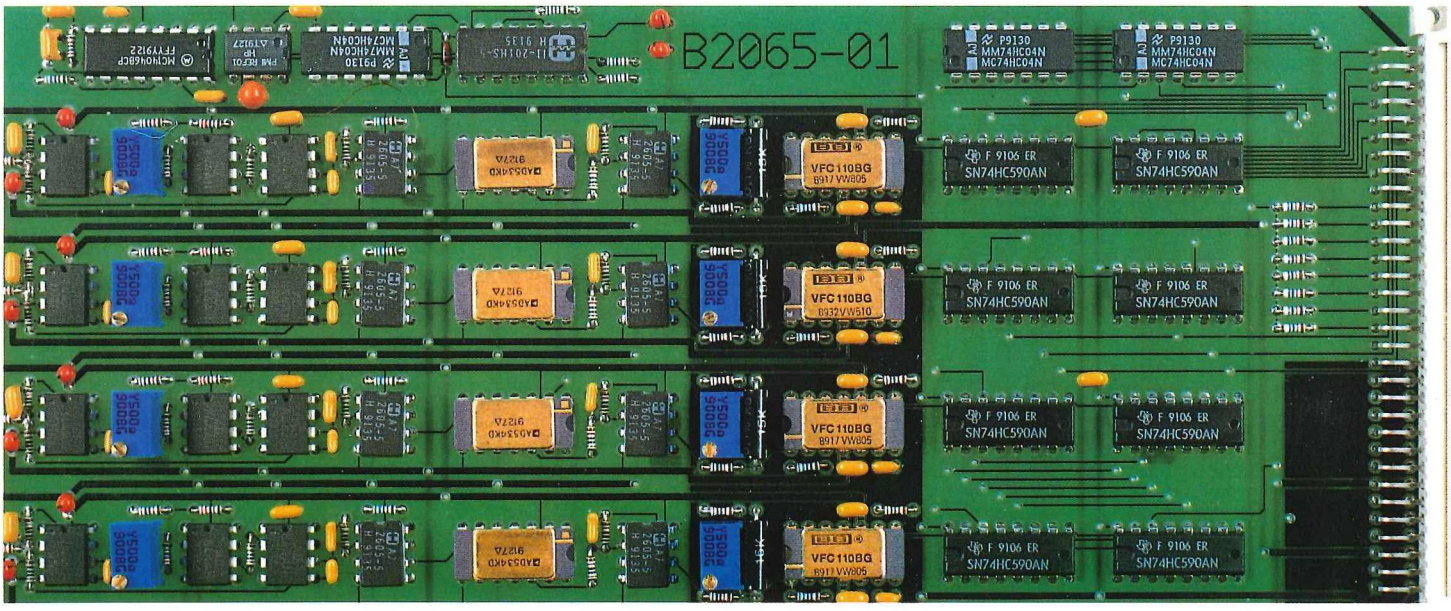

# Technology Transfer

## General

Over recent years MARIN has several times been asked to render assistance in developing hydrodynamic testing facilities and in extending the theoretical knowledge of employees in this discipline. Nowadays the strategy of newly industrialized countries is to develop their own technology. To serve these countries MARIN has set up a Technology Transfer Group. The aim of this group is to transfer knowledge in the field of hydrodynamics on a commercial basis and to supply specific hard and software for experimental research. MARIN is also willing to participate in cases where the client wants the delivery of turnkey systems with large capital investments such as buildings with utilities and instruments. Thyssen Rheinstahl Technik GmbH and MARIN are cooperating in several projects to combine security in capital investments and knowledge. So far a number of projects are in progress with an excellent working relationship between the two parties.

## Services

From the expertise gained in previous projects, the following services have been developed:

*Consultancy*

This includes all activities in relation to the design and building or improvement of hydrodynamic laboratories. Such consultancy projects begin with advice on the dimensions of the facilities in relation with the requirements of the owner, continue through preparation of specifications and tender documents and conclude with Project Management Consultancy during the building phase.

*Operational training*

Training programs are developed and can be delivered by MARIN experts to members of staff of hydrodynamic laboratories. The training can be customised and covers the fields of ship powering, cavitation and offshore testing, including evaluation. Training programs for ship and propeller model production and drawing office training are also available.

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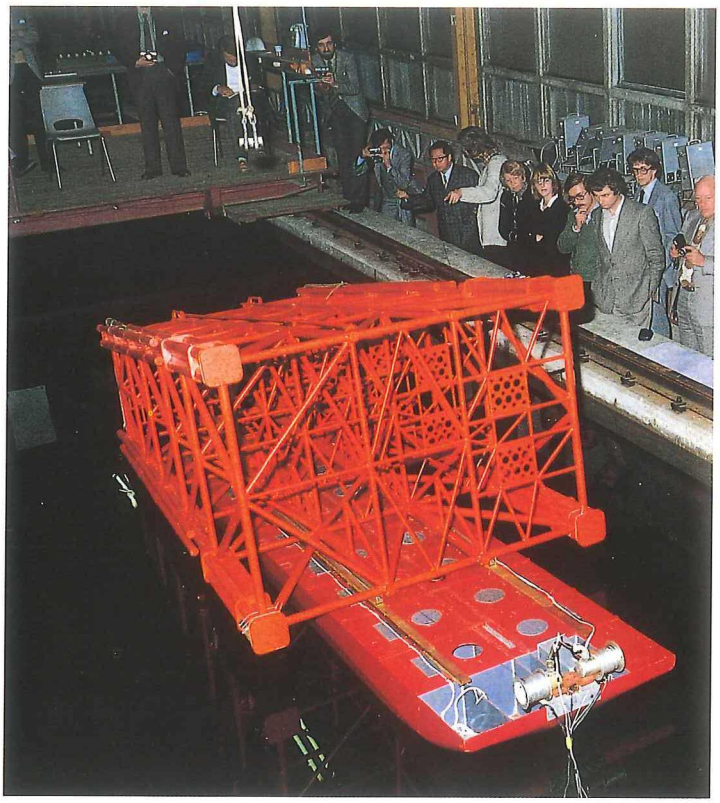

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*Operational assistance*

In many cases, especially where newly set up laboratories are involved, the operational training may need to be followed by operational assistance during the start-up phase. This assistance includes on-the-spot training by MARIN experts.

*Postgraduate courses on hydrodynamics.*

MARIN is prepared to deliver courses to graduates on specific hydrodynamic subjects.

## Products

During its 60 years of existence, MARIN has had to solve a number of measuring and production problems. Consequently, instruments, software and hardware have had to be developed in order to maintain MARIN's leading role in the field of hydrodynamic research.

Prime examples of these products are:

- Data acquisition and analysis systems.
- Model position measuring system with optical tracking system with an accuracy of ±1 mm.
- Servo controlled wave height probe to be used on carriages at high speed.
- Hard and software for numeric model and propeller production.
- Special transducers.

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MARIN

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands

Telephone +31 8370 93911
Telex 45148 nsmb nl
Telefax +31 8370 93245

## Example of a project in progress

*Indonesian Hydrodynamic Laboratory in Surabaya.*

For a number of years, MARIN has been involved in the development of plans for the design, construction and commissioning of a new Indonesian Hydrodynamic Laboratory in Surabaya.

The policy of the Indonesian government is directed towards the development of a high-tech industry. Therefore the development of research facilities for each industry is a matter of prime importance.

An Aerodynamic Laboratory has already been established in Serpong. The activities of this Laboratory are closely related to the Indonesian aircraft industry.

The shipbuilding industry is also of prime importance in the future development of Indonesia with its large archipelago and it is obvious that a Hydrodynamic Laboratory needs to be established. This Laboratory will provide the future focus of hydrodynamic knowledge in Indonesia, based upon a skilled staff of scientists, well qualified software developers and highly trained technicians able to execute and evaluate tests and manufacture models, instrumentation and electronics.

The assistance MARIN is providing in this development is manifold:

*Design assistance*

This involvement comprised assistance in the design of the general layout of the Laboratory. For this purpose an environmental, marketing and feasibility study was carried out by MARIN. The results were laid down in the requirements and specifications for the laboratory and equipment in order to enable a proper tender procedure to take place.

*Project management consultancy*

Substantial assistance is being given in the form of management consultancy during the building of the Laboratory. A field team under the direction of MARIN is permanently present at the building site in Surabaya.

*Special supplies*

In addition to the support described, MARIN is also supplying some special equipment for the Laboratory.

A main feature is the delivery of the latest development in model position measuring equipment. This is a contactless measuring system detecting the 6 modes of motion without hampering the model by data transmission cables.

MARIN software, developed and validated in-house and dedicated to the process of efficient model testing and efficient processing of large quantities of data is also to be installed.

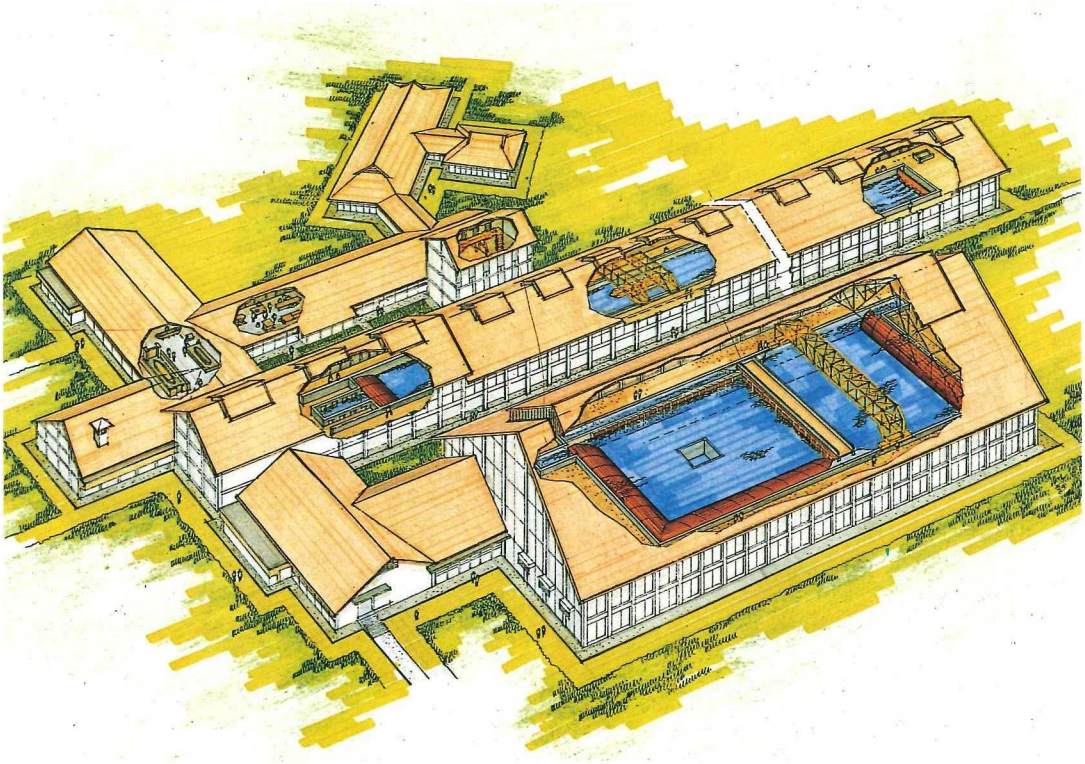
*Training programs*

A substantial training program has been set up in the Netherlands for the training of a nucleus of the future crew of the Indonesian Hydrodynamic Laboratory and there is also to be an assistance program for the starting-up phase after the laboratory is brought into commission.

*Data on the new facilities in Indonesia*

The Laboratory in Surabaya comprises a long Towing Tank measuring 235 x 11 x 5.5 m, a Cavitation Tunnel with a measuring cross-section of .85 x .85 m and a Manoeuvring Offshore Basin. This Basin consists of a deep (60 x 35 x 2.5 m) and a shallow part (45 x 35 x 1.25 m). The three basins are equipped with sophisticated wave-making equipment.

All facilities are provided with fast Data Logging and Analysis systems and an appropriate off-line computer system is to handle detailed analysis and support the mathematical simulations.



## Technology Transfer Group/ organisation and contacts

The Technology Transfer Group is part of the MARIN organisation and consists of a permanent staff in Wageningen. It can temporarily be extended by MARIN specialists where needs and workload require.

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# How to contact MARIN

**Call:**
Telephone: +31 8370 93911
Fax: +31 8370 93245
Telex: 45148 NSMB NL

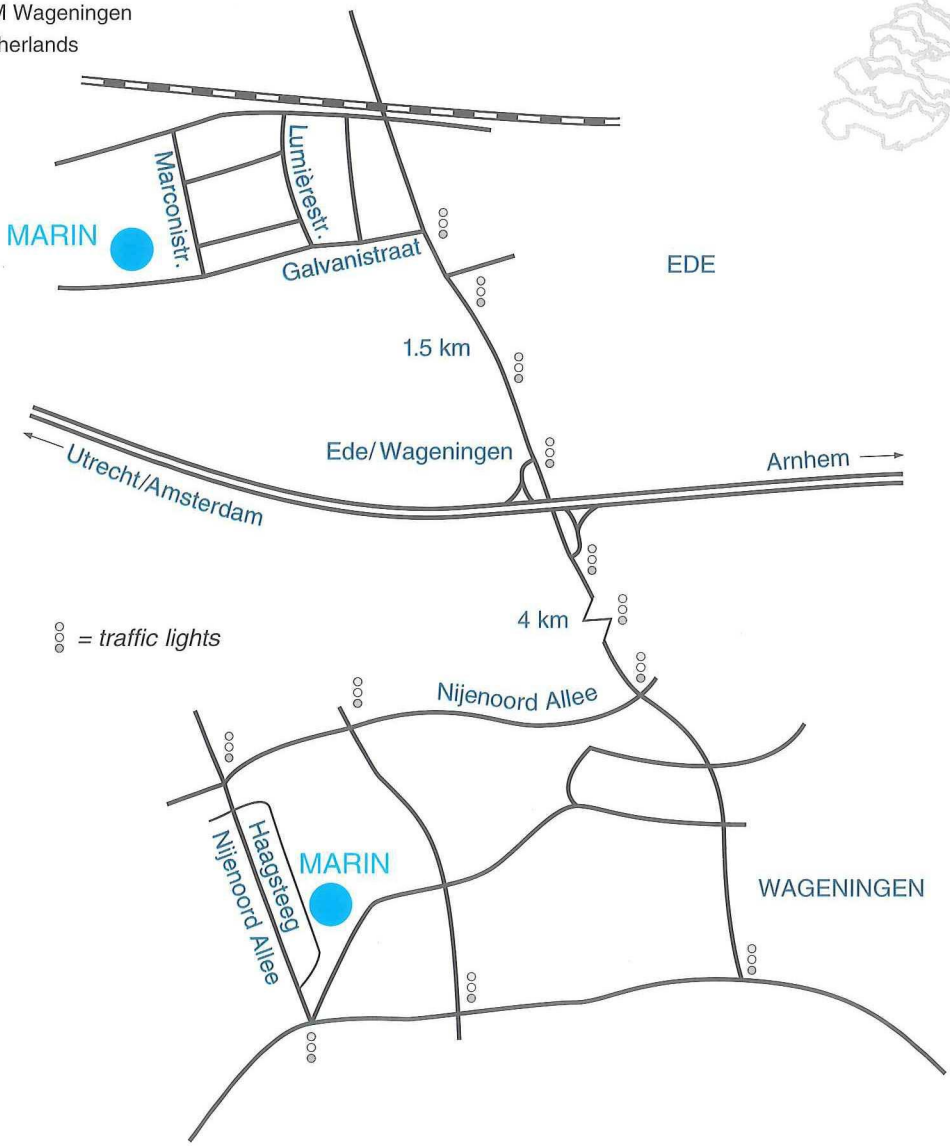
**Write:**
P.O.Box 28
6700 AA Wageningen
The Netherlands

**Visit:**
2 Haagsteeg
6708 PM Wageningen
The Netherlands

**By Public Transport:**
Train to Arnhem, get off at Ede-Wageningen.
Buses 83 and 85 stop in front of MARIN (or take a taxi).

**By car:**
Highway A12 direction Arnhem.
Leave the A12 for Wageningen and follow the below route:

**Depressurized Towing Tank:**
16 Galvanistraat
6716 AE Ede
The Netherlands

MARITIME RESEARCH INSTITUTE NETHERLANDS

MARIN

**Direct dialling numbers:**

MANAGING DIRECTOR
* *M.W.C. Oosterveld*,
+31 8370 93219

ADMINISTRATION & FINANCE
* *P.B.M. Badoux* (head),
+31 8370 93264

PUBLIC RELATIONS & MARKETING
*E.R. Dolfin*,
+31 8370 93305

PERSONNEL SERVICES
* *J. Kranenbarg* (head),
+31 8370 93214

SHIP RESEARCH DEPARTMENT
* *J. Th. Ligtelijn* (head),
+31 8370 93485

*U. Nienhuis* (projects),
+31 8370 93484

OFFSHORE DEPARTMENT
* *S.G. Tan* (head),
+31 8370 93326

*J.E.W. Wichers* (projects),
+31 8370 93351

SOFTWARE ENGINEERING
* *H.J.J. van der Boom* (head),
+31 8370 93353

*M. Th. van Hees* (projects),
+31 8370 93468

AUTOMATION & INSTRUMENTATION DEPARTMENT
* *J. van der Kooy* (head),
+31 8370 93475

TECHNOLOGY TRANSFER
*C.M.J. Gommers*,
+31 8370 93291

* *Member of the management team of MARIN*