HYDRODYNAMIC SERVICES

KONGSBERG

KONGSBERG ENGINEERING SERVICES

Cavitation tunnel testing

Unlike other propulsor suppliers, KONGSBERG has its own marine propulsion laboratory in Kristinehamn, Sweden, giving a unique capability of KONGSBERG to combine in-house experimental testing and numerical simulations build confidence in CFD models used for design and optimisation.

Kongsberg Hydrodynamic Research Centre (KHRC) is one of the world's leading marine hydrodynamic research facilities, specialized in the development of marine propulsion systems including the design and testing of propellers, rudders, thrusters and waterjets. KHRC is equipped with two cavitation tunnels, one free-surface and one conventional tunnel.

This testing capability is available also for our customers, as a hydrodynamic service, to support design, optimisation and verification.

Free-surface cavitation tunnel – T-31

The free-surface tunnel at KHRC is one of few tunnels of this type in existence and is used for testing propellers operating in partially or fully submerged conditions, in parallel or oblique flow or behind a hull dummy. The tunnel is particularly suitable for testing waterjet units as a complete system with inlet, pump and steering/reversing unit as well as hydrofoil configurations. In addition, a special test station in the large de-aerating section enables various interaction phenomena between propulsors and hull structures, at or near bollard pull conditions, to be investigated.

CAVITATION TUNNEL TESTING

- Propeller & hull cavitation test
- Propeller open water test
- Propeller, rudder, nozzle test
- Cavitation erosion resistance testing
- Thruster/POD cavitation test
- Thruster/POD bollard pull test
- Waterjet system cavitation test
- Waterjet pump loop test

Examples of test and measurements that can be done in the free-surface cavitation tunnel is:

- Propeller in-behind tests with cavitation observations and pressure pulse/noise measurements.
- Waterjet system test with cavitation observations and thrust/torque measurements.
- Thruster/POD propeller and stay load measurements.
- Bollard pull measurements taking the effect of cavitation into account.
- Hydrofoils with cavitation observation and drag/lift measurements taking the effect of cavitation into account.

Conventional cavitation tunnel – T-32

The conventional tunnel at KHRC is primarily intended for testing propellers, waterjet pumps and thrusters in “open water“ conditions, i.e. homogenous inflow with or without the effects of cavitation. The upstream drive unit is adapted to various shaft, hub and blade dynamometers, allowing measurement of torque and thrust of the entire propeller or, alternatively, forces acting on an individual blade. Special tests can be performed, such as measurement of velocity distribution and propeller, rudder or nozzle combinations, or any kind of test with underwater objects, when the presence of a free surface is not required.

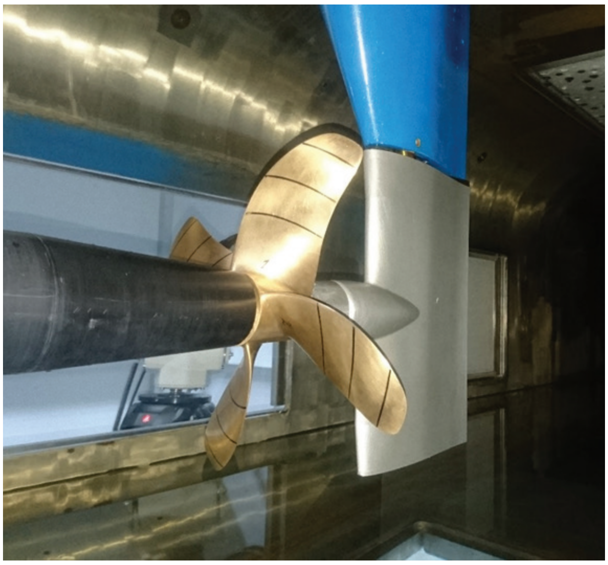
Examples of measurements that can be done in the conventional cavitation tunnel is:

- Propeller open water test at any conceivable condition of operation.
- Pump loop tests.
- Propeller/rudder or nozzle combinations.
- Contra-rotating propellers.

Propeller & hull cavitation test

Thruster/POD cavitation test

Propeller open water test



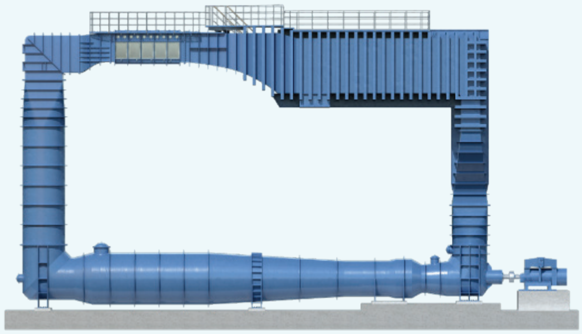
Propeller & Rudder/Nozzle cavitation test

TECHNICAL DATA OF KHRC CAVITATION TUNNEL

FREE SURFACE CAVITATION TUNNEL T-31

Kempf & Remmers – Hamburg

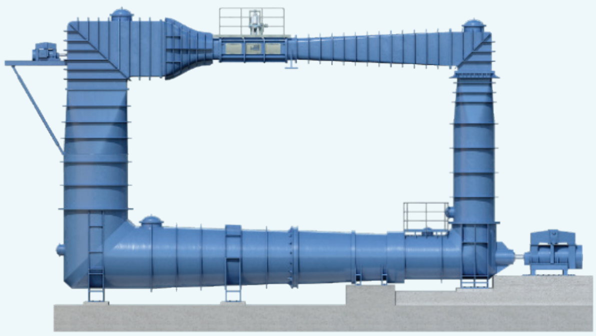
Build year	1970
Tunnel volume	394 m³
Drive engine	1000 kW
Total height	12 m
Total length	23 m
Measuring section	
Height	800 mm
Width	800 mm
Length	4 m
Water velocity	12 m/s
Abs. pressure	max 100 kPa min 5 kPa

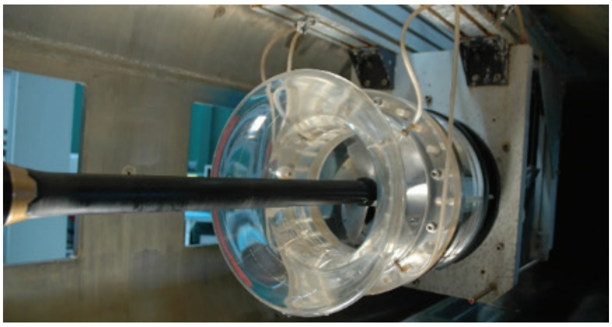


CONVENTIONAL CAVITATION TUNNEL T-32

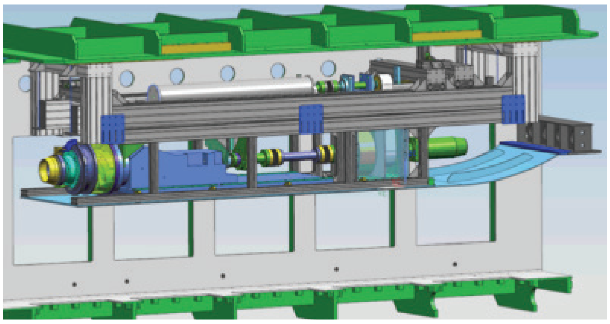
KMW

Build year	1970
Tunnel volume	117 m³
Drive engine	250 kW
Total height	8 m
Total length	14.5 m
Measuring section	
Height	800 mm
Width	800 mm
Length	2.5 m
Water velocity	14 m/s
Abs. pressure	max 200 kPa min 15 kPa





Waterjet pump loop test



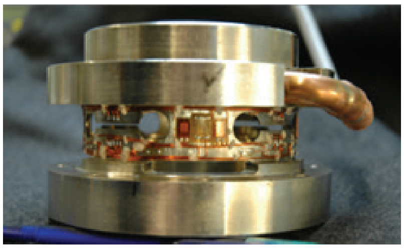
Waterjet system test

Measurement techniques & Instrumentation

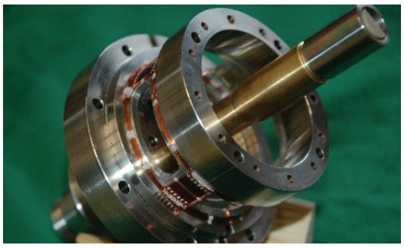
For most kind of testing work, in model- or full-scale, the accuracy and reliability of control and measuring equipment is of great importance. In cavitation tunnel testing, where the environmental conditions are often quite extreme (moisture, low pressure, vibrations), the quality of measuring and control systems becomes a critical matter. Most dynamometers, gauges etc. must be tailor made for their purposes and it is necessary not only to find the best components in the systems, but also to have specialists designing, building and maintaining them. KHRC has the necessary competence and experience provided by our measurement engineers. In addition, for the testing work related to our core business, they are responsible for the development of measuring techniques for all kinds of unusual measurements.

Typical dynamometers available at KHRC are:

- Thrust and torque 2-component dynamometers.
- 1-component dynamometers for axial nozzle/rudder force measurements.
- 5 component dynamometers for thruster stay, single propeller blade or rudder force/torque measurements.



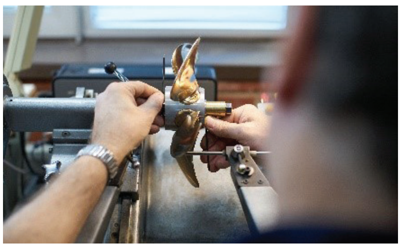
5-component dynamometer



5-component dynamometer

Strain measurement WJ-impeller

Ongoing testing controlled by the test operator



Pitch adjustment model propeller

MEASUREMENT TECHNIQUES & INSTRUMENTATION

Stress and load measurements

- Strain gauges
- Thrust and torque dynamometers
- 5-component dynamometers for single blade- or stay loads
- 3-component dynamometers for stay/rudder loads
- 1-component dynameters for rudder/nozzle forces

Pressure, noise, vibrations

- Pressure gauges for pressure pulse measurements
- Hydrophones for underwater noise measurements
- 3-axis accelerometers

Video techniques

- HD standard digital video cameras used with stroboscopes
- High speed video camera (Photron Fastcam SA-X2)

Water velocity measurements

- Laser Doppler Anemometer (LDA)
- Pitot tube measurements
- 3D-velocity measurements
- Wake field measurements

Water flow measurements

- WaterMaster FEV121 electromagnetic flow transmitter

Material testing

- Cavitation erosion test-rig
- Material erosion resistance test (relative weight loss due to cavitation erosion)

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