



EDUCATIONAL MARINE HYDRODYNAMICS

Cussons
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CUSSONS MARINE HYDRODYNAMICS EDUCATIONAL RANGE



Cussons Technology founded in 1872 in Manchester, England is an organisation with a proven record of design and manufacture of equipment used in Research, Development and Education. Today, as part of the Trident Analytical Group, the company offers a wide range of products and services to an international customer base.

The Cussons Technology Marine Hydrodynamics Division was founded following the acquisition of Kempf and Remmers.

Kempf and Remmers commanded universal recognition for excellence in the design and manufacture of a wide range of specialised force measurement instrumentation and test facilities systems for the marine hydrodynamic research

sector. These facilities are principally employed in the evaluation of hull designs, propulsion systems and sea-keeping characteristics of a wide range of surface and sub-surface vessels and other marine structures.

Combining its skills and experience in design, manufacture, installation and operation of projects with the Kempf and Remmers business, Cussons Technology created the world's most formidable force to serve the Marine Hydrodynamic research establishments.

This is a specialised division based within the UK's key hydrodynamic research facility at QinetiQ Haslar, Portsmouth on the South Coast of England. Our offices are located within Froude's original Haslar tank on the site that is now part of the Haslar Marine Technology Park.

Cussons are able to provide clients with all of the requirements for Marine Hydrodynamic Research and Development from spare parts to facility upgrades including new instrumentation to completely new facilities as available in the new educational range designed that are specifically designed for smaller facilities in Universities or higher education applications.



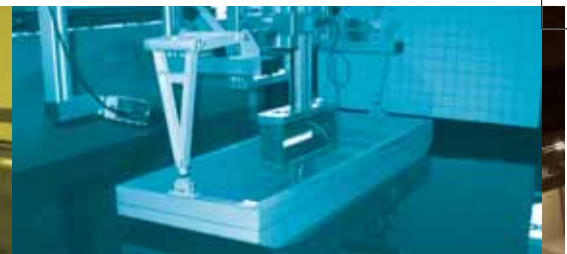
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EDUCATIONAL MARINE HYDRODYNAMICS INDEX

Cussons Technology has built on the success of its Kempf & Remmers Range of Research Hydrodynamics test equipment and its knowledge of tertiary educational engineering equipment to produce a new range of Educational hydrodynamic equipment to complement smaller facilities. The Equipment is designed to be robust for student use, and consistent in its results and accuracy as many of the components are inherited from the Kempf & Remmers Range. The Purpose is to allow the lecturer demonstrations to be carried out with ease, and for the students to undertake a range of experiments with repeatable results and reasonable accuracy.

The Products are designed to be cost effective and complementary. Each product can be sold as individual product range, but when supplied within a complete facility some savings can be achieved by the use of a common data acquisition system.



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EDUCATIONAL CAVITATION TUNNELS

K14	Educational/Research Cavitation Tunnel
K14E	Educational Cavitation Tunnel.
K17E	Small Educational Cavitation Tunnel.
K23	Small Research Cavitation Tunnel / CWC

EDUCATIONAL RANGE CAVITATION TUNNEL DYNAMOMETERS

N11E	Wake rake with integrated pressure transducers for use Tunnels
R25E	External Mounted Dynamometer for use in Tunnels
R30E	Water Tight 3 Component Balance for use in Tunnels
R35	Water Tight Single Component Balance for use in Tunnels
	Pitot Static Tube for use in measuring section of Tunnel
	High Speed / Frame Rate Camera system for observing cavitation.
	Flat Plate and Cylinder Model Experiment for use in Tunnels

EDUCATIONAL TOWING CARRIAGES

C15e	Educational Towing Carriage design to suit a towing tank 1.5m wide
C20e	Educational Towing Carriage design to suit a towing tank 2m wide.
C30e	Educational Towing Carriage design to suit a towing tank 3m wide.
C40e	Educational Towing Carriage design to suit a towing tank 4m wide.

EDUCATIONAL RANGE DYNAMOMETER AND INSTRUMENTS

H75E	Open Water Propeller / Turbine Dynamometer
N10E	Wake rake with integrated pressure transducers
R23E	Small Carriage Mounted Wave probe equipment
R42 / R43	Traditional K&R Self-propulsion Dynamometer for small models
R28E	Small Model Alignment / Guiding Arms
R35E	Resistance Dynamometer and Towing post
R75E	Ship model Self Propulsion Dynamometer
V110E	Dynamic Ship stability dynamometer
V122E	Stationary High Speed Camera system
V140E	Educational Modular Ship

EDUCATIONAL WAVEMAKERS & WAVE ABSORBING BEACHES

W15E-W40E	Wet Back Hinge Flap Regular and Irregular Wave Maker
W20EB-W40EB	Tuneable Wave Absorbing Beach
R23E	Carriage wave probe

MODEL MANUFACTURE

B20E to B40E	Small CNC 3 Axis Ship Model Milling Machines
B2-1E	Small Stern Tube Drilling Machine
D25	Traditional K&R Propeller Drill Point Measuring Machine
R1-20E or 30E	Ship Model Moment of Inertia Apparatus



EDUCATIONAL CAVITATION TUNNELS

We have a range of small Cavitation Tunnels developed from the Kempf and Remmers Range of Tunnels. The Tunnels are manufactured from high grade materials to resist corrosion and fouling.

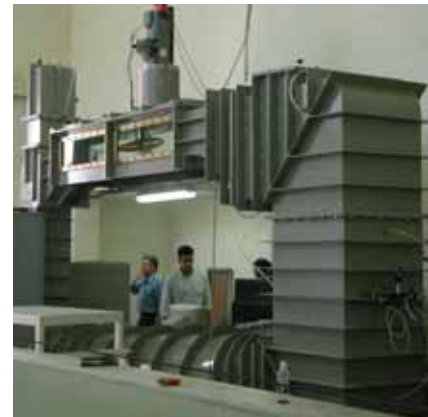
There is a full range of equipment available for these facilities including Open-water propeller dynamometers,

force and moment balances, wake rake and pitot static tubes.

All the Educational Range of Tunnels can be supplied with optional control and data-acquisition systems - from simplified Manual Control Station with USB Interface Data Acquisition through to more advanced automated Control and Data Acquisition, allowing the control of the tunnel, as well data logging and running of test.

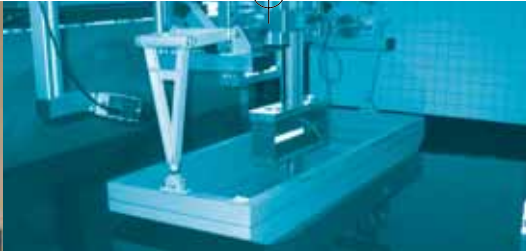
EDUCATIONAL CAVITATION TUNNELS

K14	Educational/Research Cavitation Tunnel with 230mm x 230mm Measuring Section Max Speed 8m/s
K14E	Educational Cavitation Tunnel with 230mm x 230mm Measuring Section Max Speed 5m/s
K17E	Educational Cavitation Tunnel with 230mm x 230mm Measuring Section Max Speed 4m/s
K23A	Small Research Cavitation Tunnel with 3 different measuring sections available: -300mm x 300mm Measuring Section Max Speed 9m/s -425mm x 425mm Measuring Section Max Speed 5m/s -Free Surface 630mm x 350mm Measuring Section Max Speed 4m/s
AutoTest 4e	All Cavitation Tunnels can be supplied with Optional AutoTest control and Data acquisition system
CuDaq	K17E & K14E Can be supplied with optional Manual Control and CuDAQ Data Acquisition System



EDUCATIONAL RANGE OF CAVITATION TUNNEL INSTRUMENTS

N11E	The N11E Educational Wake rake with integrated pressure transducers for measuring the wake profile with in the tunnel.
R25E	External Mounted Dynamometer for use in Educational Cavitation Tunnels for Open Water Propeller testing in the following ranges: -Rated Max Torque $\pm 10\text{Nm}$, Rated Max Thrust $\pm 250\text{N}$ at 2000rpm -Rated Max Torque $\pm 15\text{Nm}$, Rated Max Thrust $\pm 400\text{N}$ at 2000rpm -Rated Max Torque $\pm 20\text{Nm}$, Rated Max Thrust $\pm 600\text{N}$ at 2000rpm
R30E	Water Tight 3 Component Balance for use in Tunnels
R35	Water / Pressure tight Single Component Balance for use in Tunnels
V121E	High Speed / Frame Rate Camera system for observing cavitation
	Pitot Static Tube for use in measuring section of Tunnel
	Flat Plate and Cylinder Model Experiment for use in Tunnels



EDUCATIONAL TOWING CARRIAGES

C15e	Educational Towing Carriage design to suit a towing tank 1.5m wide Approx Minimum Length 40 - 50m - Max Speed 2m/s
C20e	Educational Towing Carriage design to suit a towing tank 2m wide. Approx Minimum Length 40 - 50m - Max Speed 3m/s
C30e	Educational Towing Carriage design to suit a towing tank 3m wide. Approx Minimum Length 40 - 50m - Max Speed 3m/s
C40e	Educational Towing Carriage design to suit a towing tank 4m wide. Min Length 50m - Max Speed 4m/s (can be increased providing additional length of tank is available).
AutoTest 4e	All Carriages to be supplied with AutoTest control and Data acquisition system - Instrument interface to suit equipment supplied.

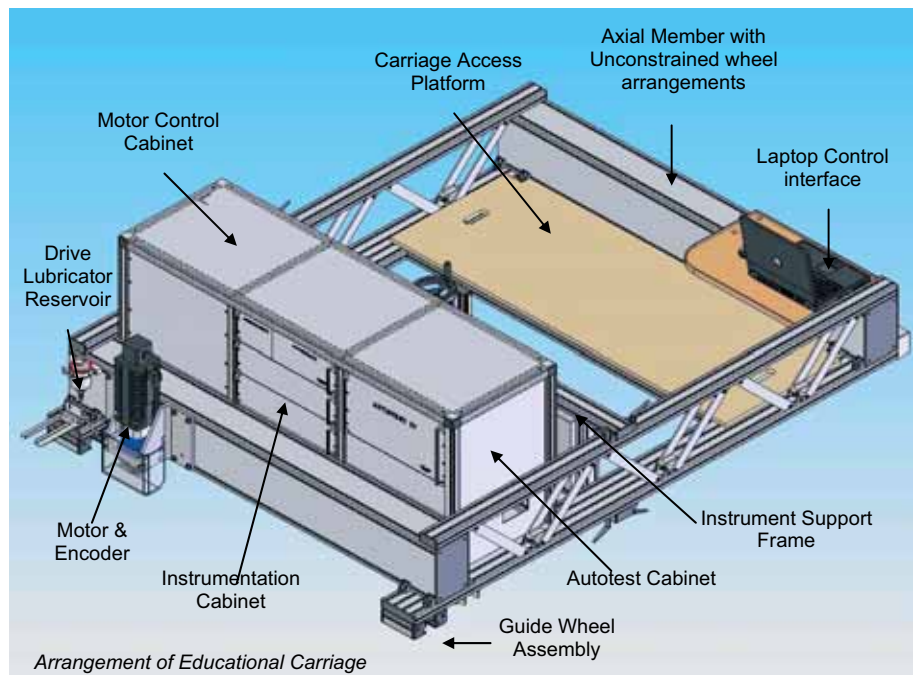
TOWING CARRIAGES

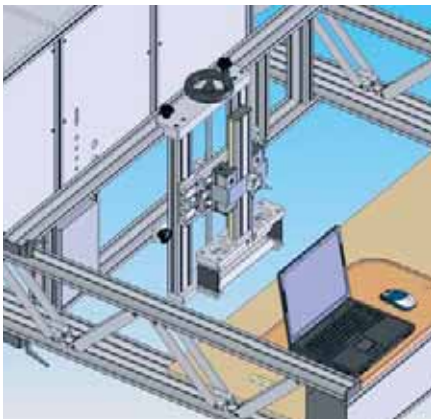
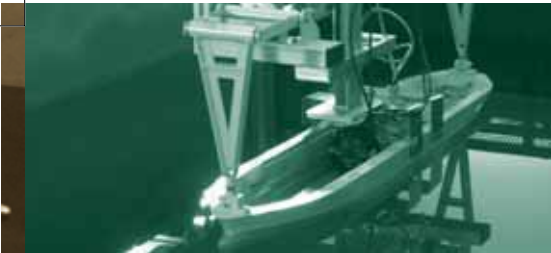
Cussons have recently introduced a whole new range of towing carriages aimed at University and Educational Institutes that do not have the room for the larger scale research grade facilities.

The new ranges of unmanned carriages are light weight and have a highly rigid & robust platform that allows a wide variety of equipment to be attached from it. The carriages are design for towing tanks from 1.5 to 4 meters wide with a minimum length of 40m upto a maximum of approximately 100m.

The carriages are designed to run at a maximum speed of 3m/s to 5 m/s depending on length of tank available. Normal Rate of Acceleration is 1m/s². Normal braking is provided at 1m/s² whilst the emergency braking system operates at up to 3m/s².

The carriages and instrument are suitable for towing models up to 2m - 3m in length and up to 30kg in mass.

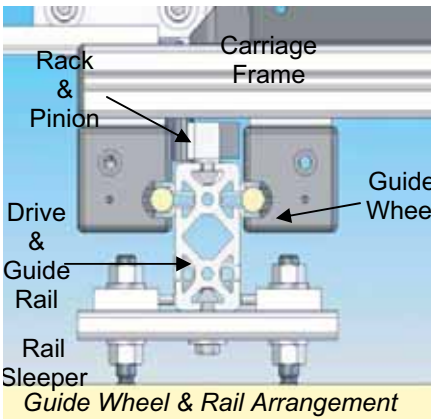




AUTOTEST

Cussons Autotest is used in the control and data acquisition on the educational range of towing carriages. This allows a full interface between the carriage and the testing that is being undertaken. Allowing both the control and running of the carriage and test equipment as well as the data logging from this equipment.

The system will be supplied to suit the apparatus equipment supplied with the carriage however this can be expanded to suit future equipment and application requirements.



CU-DAQ

(Please note this is not an option for the carriages).

Alternatively Cussons can supply a basic control and data-acquisition system called CU-DAQ. This is a basic system for use with the lower spec tunnels or dynamometers. This rack mounted case has a USB interface and is supplied the appropriate connectors.





RESISTANCE DYNAMOMETER

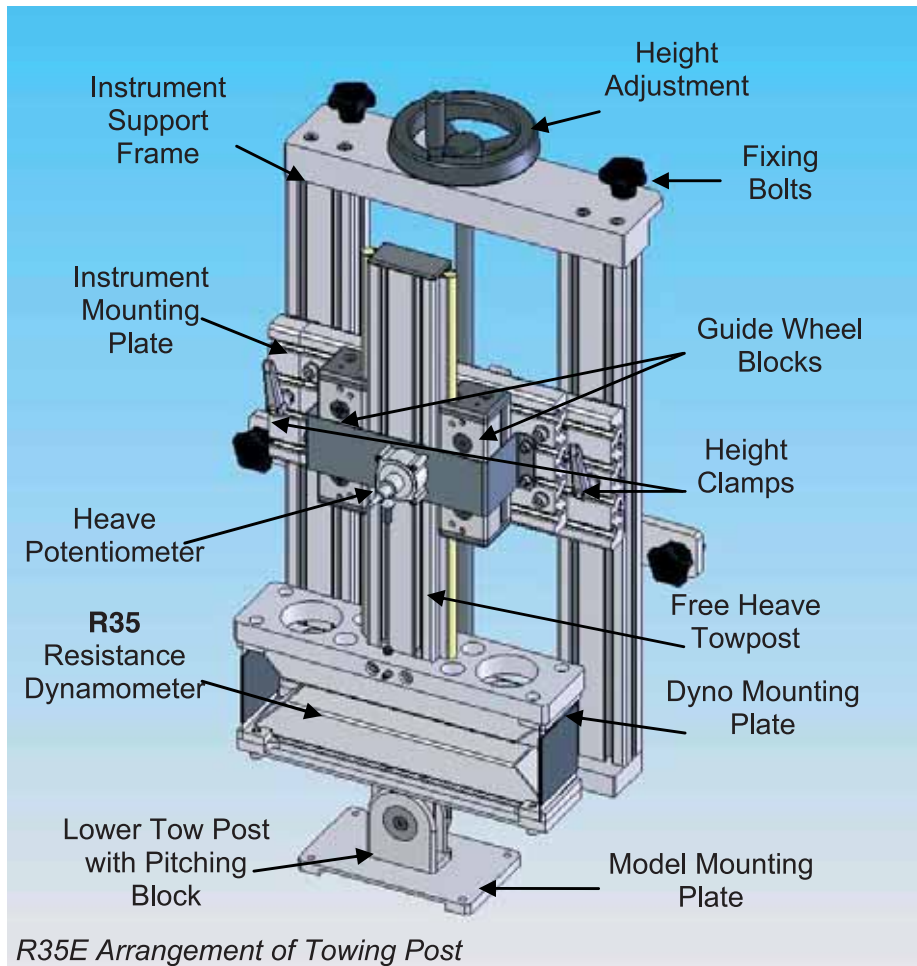
<p>R35E</p>	<p>Educational Resistance Dynamometer and Towing post arrangement is based on traditional K&R method and is capable of measuring Resistance & Heave as well as being free to Pitch</p> <ul style="list-style-type: none"> - Max Resistance is $\pm 200N$ - Heave Measurement $\pm 150mm$ (However depends on Towpost supplied) - Max Pitch Angle 30° (To Measure Pitch additional accessory required)
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RESISTANCE & STABILITY

A variety of dynamometers can be supplied for use with the carriage and support frame, including the R35E Resistance Dynamometer or the V110E Ship Stability Dynamometers. These are integral to the tow post that is normally supplied with the carriage, however if purchased as separate product, it will have to be quoted additionally.

The R35 is a traditional K&R Single Component balance that is both robust and very accurate as well as being watertight. The arrangement of the R35e in the towing post and the pitching block allow the measurement of resistance of relatively small ship models in both smooth water and wave.

When using the Resistance Dynamometers it is recommended that the Carriage is fitted with the R28E guiding arms that are designed to support the model and protect it from yawing.





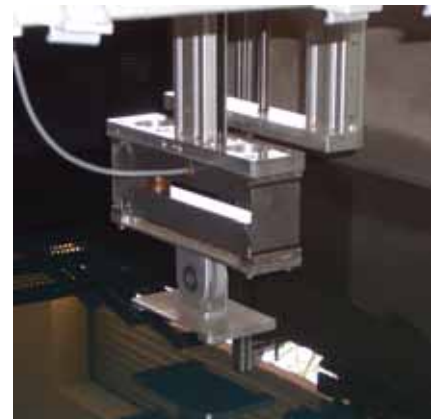
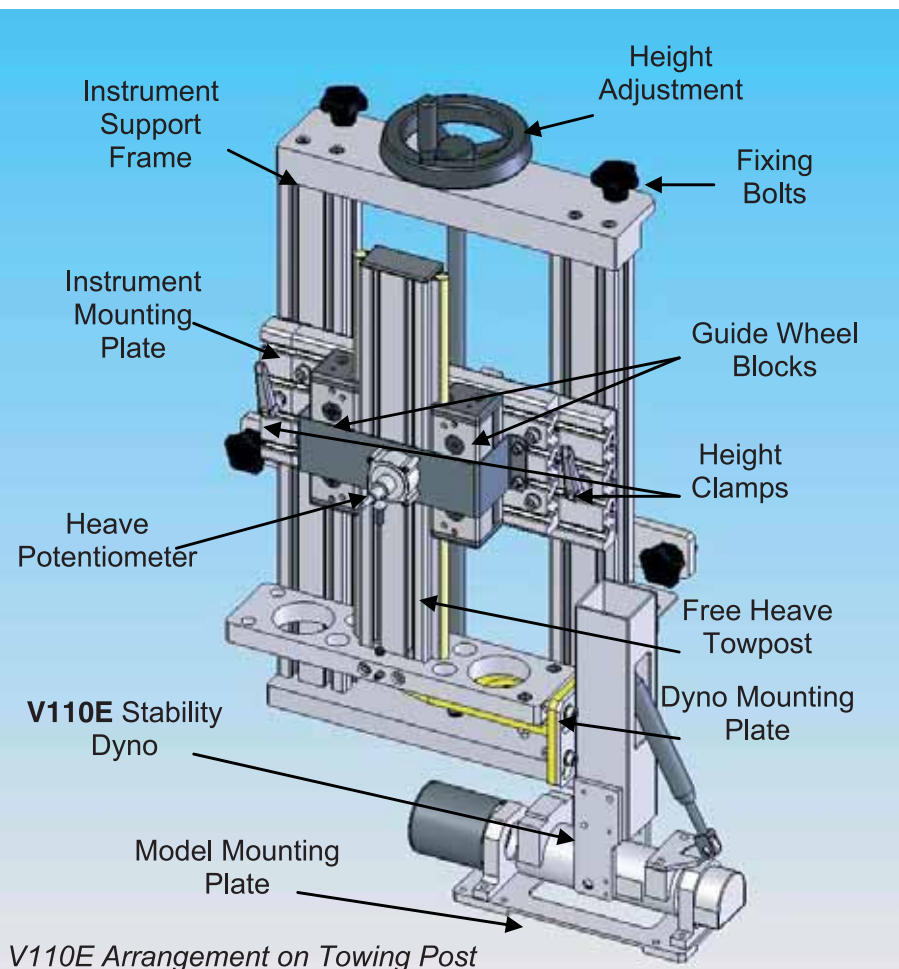
STABILITY DYNAMOMETER

V110E

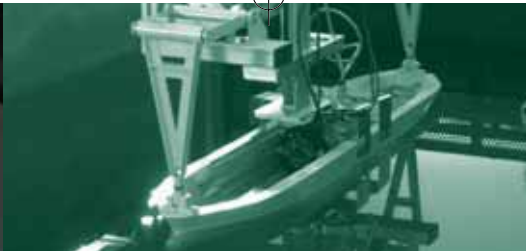
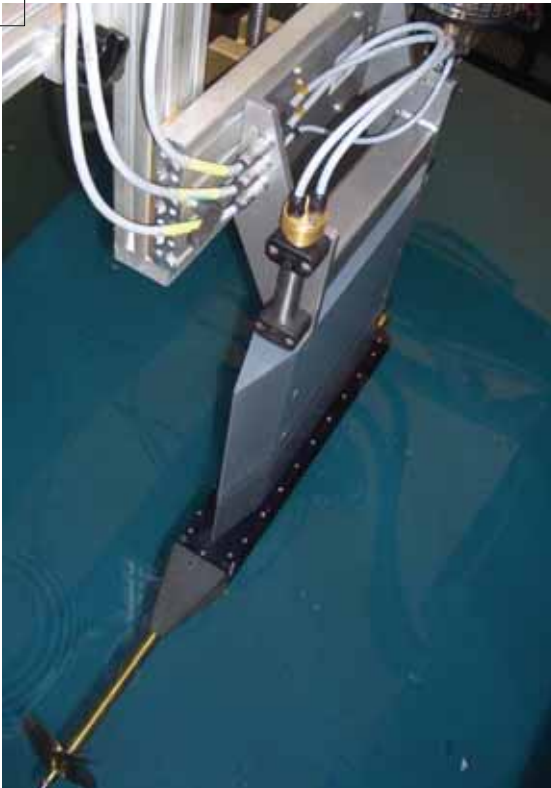
Ship stability dynamometer for testing static righting moment dynamic roll angle & righting moment of ship / structure models:

- Max Torque 80Nm,
- Maximum Permitted movement in Pitch $\pm 20^\circ$ (free or forced),
- Max Permitted movement in Roll - $\pm 30^\circ$ (free or forced)
- Maximum Permitted movement in Heave $\pm 250\text{mm}$ (dependant on tow post)

Please note this equipment can also be supplied with optional equipment V111E Stand to allow it to be mounted from the wall of a tank or flume if carriage is not available



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H75E OPEN WATER PROPELLER / TURBINE DYNAMOMETERS

<p>H75E</p>	<p>Educational Open Water Propeller / Turbine Dynamometer available in the following ranges: -Rated Max Torque $\pm 10\text{Nm}$, Rated Max Thrust $\pm 250\text{N}$ at 2200rpm in either direction -Rated Max Torque $\pm 4\text{Nm}$, Rated Max Thrust $\pm 100\text{N}$ at 2200rpm in either direction -Rated Max Torque $\pm 2\text{Nm}$, Rated Max Thrust $\pm 75\text{N}$ at 2200rpm in either direction</p>
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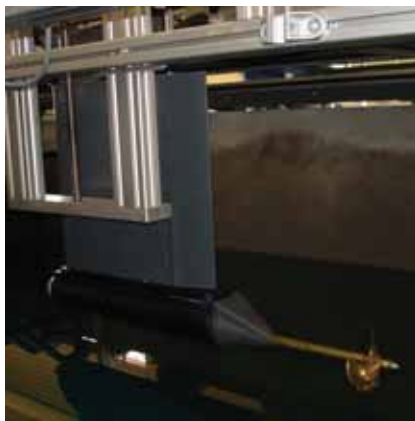
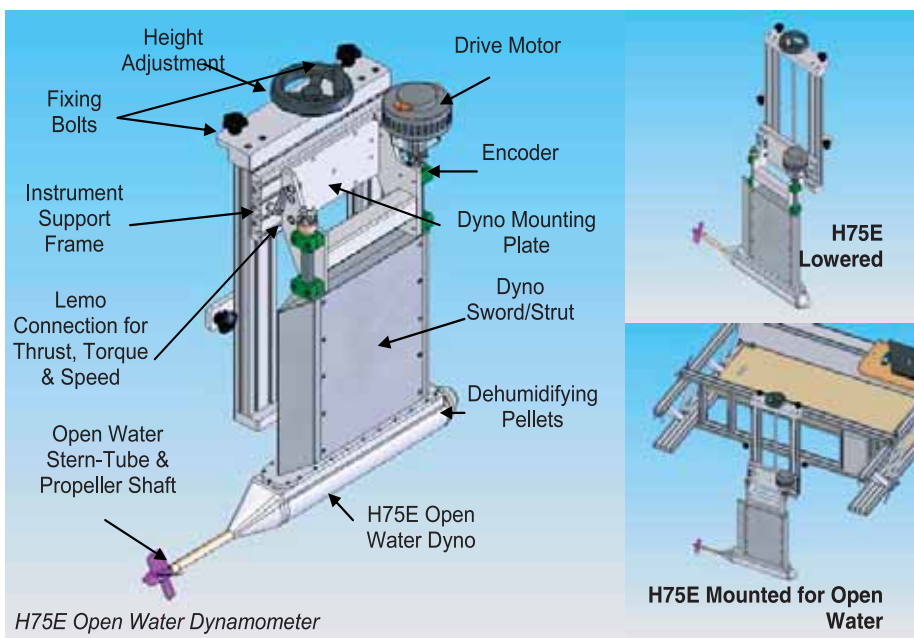
PROPELLER DYNAMOMETERS

As with the Kempf & Remmers range of equipment within the Educational Marine Range, we can supply both open water propeller dynamometers and ship model self-propulsion dynamometer.

H75E Open Water Propeller / Turbine Dynamometer.

The Standard Educational Open Water Dynamometer is called the H75E. This is an educational product which is designed using traditional K&R transducers and hence inherits the quality and accuracy within its design. The H75E can be supplied in 3 different ratings to reflect the customer's needs. This versatile dynamometer can also be used as a water turbine absorption dyno.

The H75e like the Resistance Dynamometer is designed to be mounted to the educational carriages and instrument Support frame. This allows it to be fixed securely to the carriage and at the same time enables it to be lowered or raised to the appropriate water depth





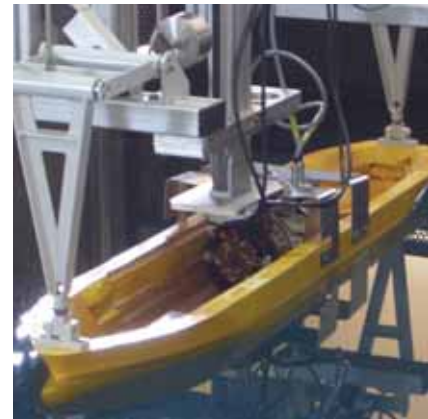
R75E Ship Model Self Propulsion Dynamometer.

The R75E Self Propulsion dynamometer is a self contained and compact unit designed to fit within small models, normally in the range of 1.2m to 2m long.

The R75E is designed to be suspended from a cross beam mounted across the gunwales of the model. (Please note that this cross beam is the responsibility of the user, as its dimensions will depend on the model.)

The R75E dynamometer is supplied with an integrated 12V DC electric motor with encoder for speed measurement. The drive motor supplies power through the propeller shaft to the test propeller.

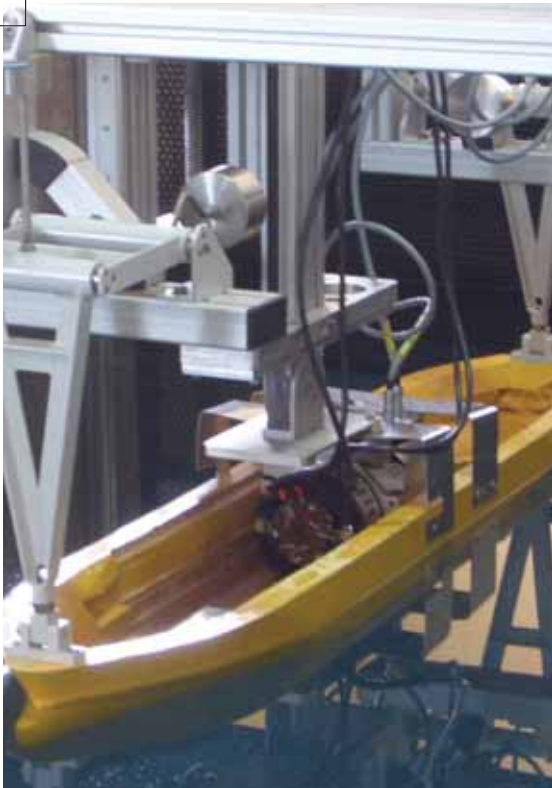
Although these are designed around the same principles as the K&R Self-propulsion Dynamometers, they are designed with a more robust and lower accuracy 1% FS suitable for handling of students. Optionally we can supply traditional research grade self propulsion dynamometers if preferred.



SELF PROPULSION PROPELLER DYNAMOMETER			
TYPE	TORQUE	THRUST	SPEED
R75E-1	3Nm	200N	1500RPM

K&F SELF PROPULSION PROPELLER DYNAMOMETER			
TYPE	TORQUE	THRUST	SPEED
R25-1	10Nm	250N	3500RPM
R31-1	4Nm	100N	3500RPM
R42-1	0.5Nm	30N	3500RPM
R43-1	1Nm	60N	3500RPM





ADDITIONAL EQUIPMENT & INSTRUMENTATION

N10E	Wake rake with integrated pressure transducers
R28E	Small Model Alignment / Guiding Arms
V122E	Stationary High Speed Camera system
V140E	Educational Modular Ship

ADDITIONAL EQUIPMENT & INSTRUMENTATION

As well as the standard resistance, stability, self propulsion and open water propeller dynamometers we also supply wake rakes, guiding arms, video capture equipment and modular ship experiment. All of which can be used in conjunction with the towing carriage.

N10E Ship Model Wake Rake

The N10E Wake Rake is a self contained and compact 4 pitot static probe rake mounted in an assembly that can be used within the ship model to measure the wake field generated from the model hull entering the propeller.

The N10E wake rake comprises of five main elements: A Rake Arm with its 4 pitot static probes, connecting drive shaft running within a drive shaft housing, motor to rotate the drive shaft and arm around the propeller shaft axis, pressure transducer bank and priming valve block and tube priming tank and feed system.



R28E Model Guiding / Alignment Arms

The R28E Model Guiding Arms are a pair of devices designed to be mounted forward/aft of the model whilst testing using the Resistance Dynamometer or Self Propulsion Dynamometer.

The arms are balanced and designed to be free to heave and pitch with the model in wave.

V122E Video Camera Equipment

The V122E camera system to detect model movement comprises of two cameras mounted on the towing carriage, one looking in the direction of the tank (for Y position), and one looking across the tank (X position). Facing each camera, behind the model is a board, etched with a grid.



The system is designed to be used with a Cussons Educational Carriage. The mounting brackets can be used directly with the slotted extrusions, used to form the main structural members of the carriage. When the V122E is to be used with other carriages, the user will need to find suitable locations for the mounting brackets and either manufacture mounting points ready to accept the V122E brackets, or adapt the V122E brackets to suit the carriage.

V140E Modular Ship Model

The V140E is a modular ship model with exchangeable bow shapes allowing teaching staff and student to conduct experiment with a model and show how the change in design of the bow will affect the hydrodynamic characteristics.





WAVE EQUIPMENT

W15E-W40E	Wet Back Hinge Flap Regular and Irregular Wave Maker
W20EB-W40EB	Tuneable Wave Absorbing Beach
R23E	Carriage wave probe

WAVE EQUIPMENT

Traditionally first principles of resistance and self propulsion tests in calm water, however following these test it is often essential to see how a design might perform in waves and how this affects its hydrodynamic characteristics. Therefore a useful addition to your facility is wave generations equipment.

Irregular Wave Generator

The Irregular Wave Generators are a single displacement flap wavemaker consisting of a paddle that is mount at its base and moved backwards and forwards by means of a rack and pinion linear actuator. The number of actuators is determined by wave specification and width / depth of tank.

The AC Servo motors are controlled by an intelligent digital drive. The drive provides all gain and damping necessary for the motor to ensure that the paddle accurately follows the position demand signal.

The wavemakers are constructed of Stainless steel and protected anodised aluminium flaps. These flaps are wet backed, however they are fitted with covers as well as a wave absorbing material / foam beach fitted behind the wave maker to stop any splash back.

The Wave Makers are Supplied with a PC and interface for control and generation of both regular and irregular waves. The installation will also include training and commissioning of the equipment.

Tuneable Wave Absorbing Beach

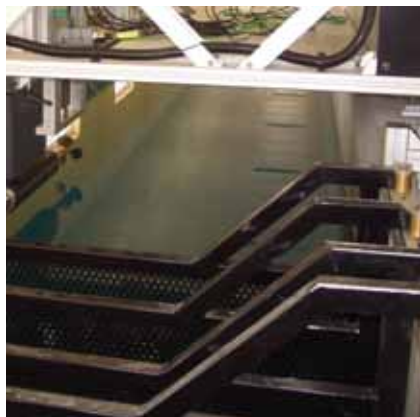
Tuneable Resonant Wave Absorbing Beach - Design to suit tank and wave specification. The screen beaches are constructed from corrosion protected material and designed to be fitted at the end of the tank. This versatile design allows the beach to be tuned to the specified wave length of the test.

In larger tanks with trimming docks it is possible to supply hybrid resonate beaches with both the vertical screens as well a further absorbing material at the entrance of the trimming dock and end of the tank on the wall.

R23E Carriage Wave Probe

The R23E is based on the traditional K&R carriage mounted wave probes. Its unique foil profile allows it to be mounted to the carriage and either measure wave height when the carriage is located statically or it can also be used to measure the wave height as the carriage is moving thus measuring the wave height at the model. This can then be connected to a data acquisition system on the carriage to log / record the data..

The Wave probe consists of a 250mm Wave Probe, a Carriage Mount Bracket and a Power supply / signal conditioning unit.





EDUCATIONAL SHIP MODEL MILLING MACHINES		
	MODEL SIZE	DESCRIPTION
B20E	2m	CNC Single High Speed spindle 3 axis Ship model milling machine with working envelope suitable for models upto 2m in bed and gantry configuration.
B30E	3m	CNC Single High Speed spindle 3 axis Ship model milling machine with working envelope suitable for models upto 3m in bed and gantry configuration.
B3000	3m	CNC Twin spindle 3 axis Ship model milling machine with working envelope suitable for models upto 3m in bed and gantry configuration.
B5000	5m	CNC Twin spindle 3 axis Ship model milling machine with working envelope suitable for models upto 3m in bed and gantry configuration.

MODEL MANUFACTURE

Model production is a major aspect of the overall operation of hydrodynamics facilities whether that is educational or research. Based on traditional K&R machines Cussons has a range of Model Manufacture Equipment that allow the accurate and rapid production of hulls, propellers and other components required for test in both Towing Tanks and Tunnels.

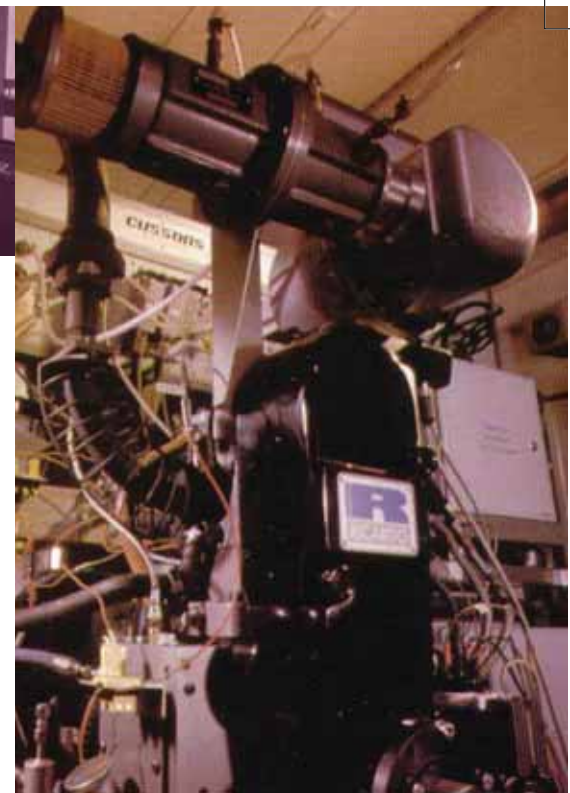
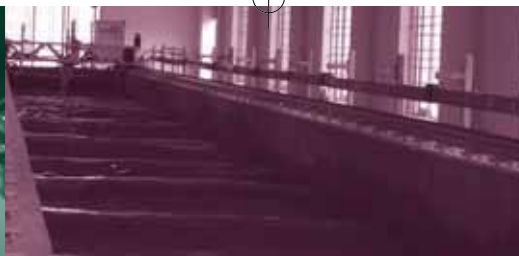
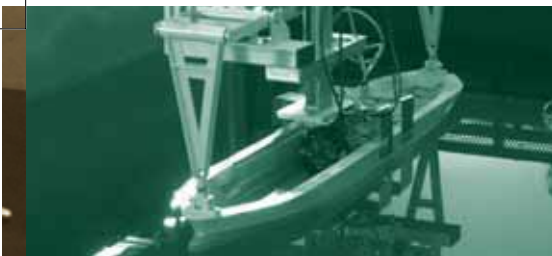
The range includes a small CNC ship model milling machine both single spindles and twin spindles, Ship Model Sterntube drilling machines, Ship Model Measuring Equipment, Marking Equipment as well as Propeller Production Measuring Machines.

STERN TUBE DRILLING MACHINES		
B2-1E	Educational	Drilling device for drilling holes for stern tubes in ship models for mount self-propulsion dynamometers and Wake Rakes. Designed for use with the B20E & B30E
B2-1	2 to 5m	Drilling device for drilling holes for stern tubes in ship models for mount self-propulsion dynamometers and Wake Rakes Designed for use with the B3000 or B5000.

SHIP MODEL MANUFACTURING ACCESSORIES	
Probe	Coordinate Measuring Probe to fit in spindle of Milling Machines and capture coordinates and measurements of models.
Scanner	3D Laser Scanner suitable for mounting to milling machine to allow measurement and digitising of models.
Waterline Marker	Device designed for marking accurately to finished model
R1-20E /30E	Ship Model Moment of Inertia Apparatus – equipment uses pendulum theory to calculate the pitch and roll moment of inertia for either upto 2m or 3m models depending on model selected.

MODEL PROPELLER PRODUCTION & MEASUREMENT	
D25	Traditional Drill Point Measuring used to manufacture and measure Model Propellers for use in Towing Tank and Cavitation Tunnel Testing - Upto 250mm Model.





THERMODYNAMIC & STEAM ENGINEERING

P7669	Miniature Steam Power Plant
P7670 / P7682	Steam Bench and Experiments
P3210	Heat Transfer Bench
P7690	1kW Steam Power Plant

MARINE ENGINES

P8652/SP	Marine Multi-Cylinder Engine Test Bed
P9005	Gas Turbine Bench

FLUID MECHANICS

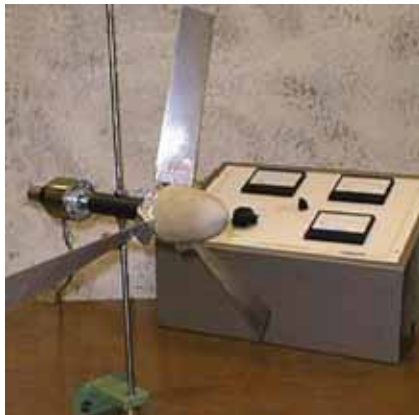
P6100	Hydraulics Bench
P6245	Flow Channel – 2.5m
P6275	300 x 450 mm Cross Section Flow Channel
P6410	600 x 500 mm Cross Section Flow Channel
P3260	Wind Tunnel (300 x 300 mm)

STRENGTH OF MATERIALS AND STRUCTURES

P4120	Structures Range Bench Top Teaching Apparatus
P5000	Free & Forced Vibration Apparatus with damping
P5030	Universal Material Testing Machine

RENEWABLE ENERGIES

P3130	Wind Generators Vertical, Horizontal Axis and Wells Turbine.
P6330 / P6345	Wave Absorbing Generators – Float, Flexible Pitch, Oscillating Air Column & Surge Channel
P6390	Tidal Energy – Tide Turbine, Barrage Scheme, Francis Turbine
P7140 & P9060	Solar Energy – Power Unit, Apparatus distillation Still
P9040	Fuel Cell Demonstration Unit



MARINE ENGINEERING EQUIPMENT

Cussons also have within the extensive range of Engineering Educational Equipment a number of Products associated with Naval and Marine Engineering. These products offer practical experiments in all fields associated with Marine Engineering such as Thermodynamics and Steam Engineering, Marine Engines, Strength of Materials and Structures, Mechanics of Fluids and Even Renewable Energies.

For a full list of Engineering Education Equipment and Products please refer to the *Engineering Educational & Training Division Brochure*.

CUSSONS
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This brochure deals with those services offered through the Marine Systems Research Division. Other divisions of the Cussons business deal with

- **Engineering Education**
- **Automotive Research and Development test beds, control, data acquisition, exhaust emissions, cvs and other related instrumentation**
- **Integrated facilities for R&D projects in Aero, Oil, Military**
- **Analysis and purification of gases for various industries**

CUSSONS TECHNOLOGY

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