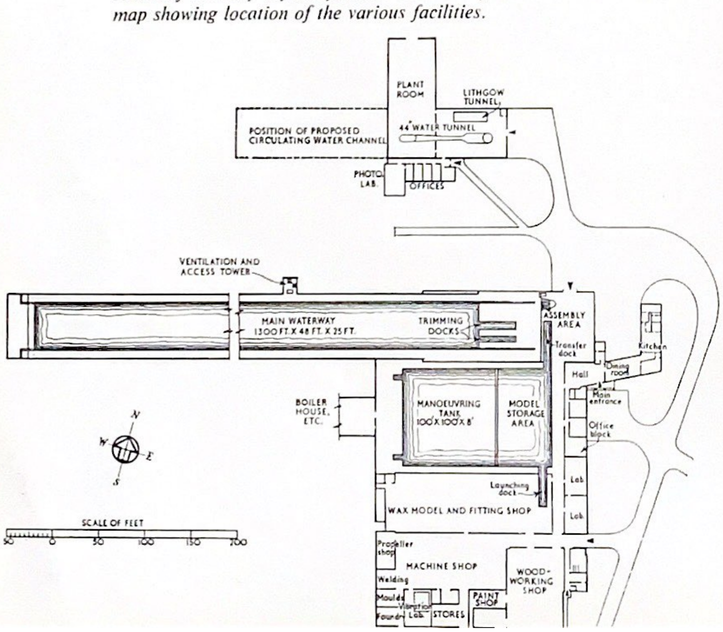
THE FELTHAM PROJECT

Where dedicated scientists make intricate ship design and propulsion studies for Britain's skilled shipbuilding industries.

Home of the Ship Hydrodynamics Laboratory at Feltham with small map showing location of the various facilities.



Roughly a century has passed since William Froude began testing model hulls in his makeshift laboratory at Torquay on England's Devon coast. His work initiated reliable techniques for determining the best hull contours in relation to hydrodynamic forces experienced at sea. This was subsequently followed by studies with model propellers to ascertain how much engine is needed to economically propel a ship according to its length, beam, and tonnage. The goal, to find the correct match of hull machinery and propeller while a vessel is still in design stage.

By 1908, growth in the demand for ship design research was such that England's National Physical Laboratory had to start a separate Ship Division. Sir Alfred Yarrow made it possible with a £20,000 gift. The money was for a towing tank at the lab's Teddington facilities. The grant specified that the tank should be used for: 1) research work to improve marine architecture and propulsion; 2) test ship models, propellers, etc., for the confidential information or British shipowners and shipbuilders.

The Alfred Yarrow Tank, completed in 1911 is still in constant use. Built of concrete, it's 500 ft. long, 30 ft. wide and 12.3 ft. deep. The government augmented it by providing funds for construction of a second tank at Teddington, completed in 1932. Longer but not as wide or deep as tank No. 1 (680 ft. × 20 ft. × 9 ft.) it incorporates a change in design from its predecessor. About 180 feet from one end, the bottom slopes upward from 9 ft. to 2 ft., providing a means for studying shoaling area effects. About the same time, Sir James Lithgow donated £5,000 to build a water tunnel for propeller cavitation studies. Still in use, but moved to a new location, it has an 18-inch-square test section and a water velocity of 30 ft./sec.

By 1945 shipbuilders' demands for resistance and propulsion tests were more than the facilities at Teddington could handle. Even with considerable overtime work, nine-month delays were usual for putting a test in work. Equally frustrating was the fact that no time or effort could be devoted to pure research. Building a new tank with improved facilities was imperative.

Though recommendations for expanded research facilities were accepted in 1946, actual construction did not start until 1955. Various forces responsible for the delay are not pertinent to our story. The facts are the Ship Hydrodynamics Laboratory was built at Feltham, roughly four miles from Teddington, and opened by HRH The Duke of Edinburgh on October 19, 1959.

Heart of the new laboratory is a towing tank. Housed in its own bay, the tank is 1,300 ft. long, 48 ft. wide, and 25 ft. deep. Nearly twice as long as the largest at Teddington, it greatly expedites normal test procedures. The reason—a number of ship speeds can be simulated in one run down the tank. This feature greatly reduces time lost between single-speed runs in a short tank waiting for the water surface to calm. But not all tests require calm water.

Investigations on the behaviour of vessels in a seaway is also important in determining hull forms. Rough water is the job of a wavemaker installed at one end of the tank. It's capable of making waves from 5 ft. in length and 6 in. in height to 40 ft. in length and 2 ft. in height (crest to trough). A number of wave-size combinations are possible within these limits. Physically, it's a 17 ft. high, wedge-shaped plunger that spans one end of the tank. Driven by hydraulic rams, its movement is vertical. The rams are operated by pumps controlled through a sinusoidal pressure cycle, producing regular wave trains. Varying the pressure cycle generates irregular wave patterns, the kind most frequently encountered at sea. The hook-up makes it possible to test a hull model under virtually every Beaufort Number sea.

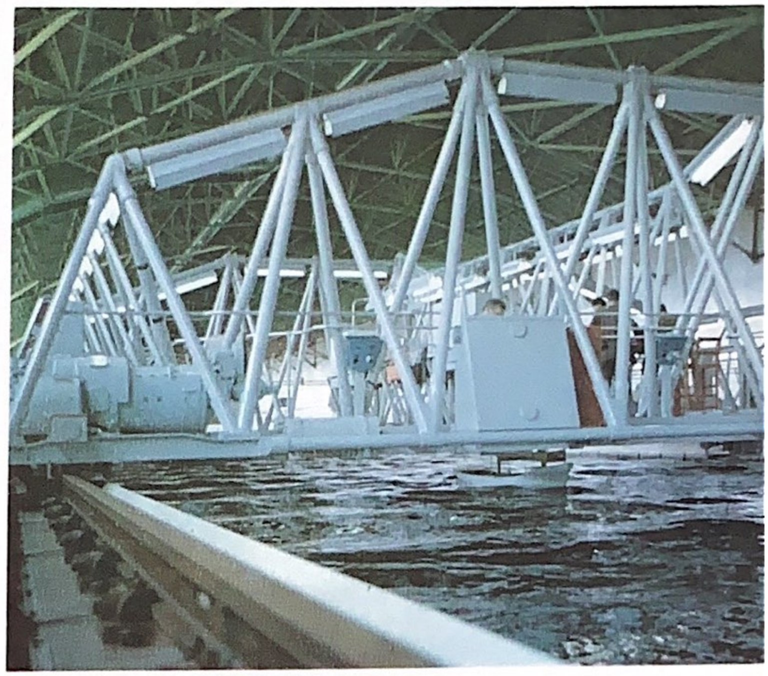
In a confined area such as a tank, wave reflections can be a nuisance. To control them the tank has a beach system. There's a beach in front of the wavemaker, one at the far end and one along each side of the tank. The one at the far end prevents wave reflection while the other three help control it. All four can be raised or lowered in accordance with the test procedure being followed.

Hydrodynamic investigations are conducted from the mobile towing carriage straddling the tank. It can tow ship models ranging up to 40 ft. in length, and weighing in at five tons. Provided with more than ample power, the roughly 50 ft. × 50 ft. self-propelled carriage is equipped with a fantastic collection of instruments. Skilled scientists interpret this instrumentation and come up with recommendations that can change design concepts to conform with performance factors. Speed of steaming the tank from one end to the other must also be accounted for. At Feltham, the carriage can make knots with a test hull up to 30. Such speed is not required for most hull displacement work but is used for procedures involving hydrofoil vessels, high speed craft and propellers.

Propeller design studies have turned up several interesting channels needing further exploration. For example, increases in the size and required service speed of ships underlines the importance of cavitation. Cavitation is the partial vacuum around propeller blades caused when they rotate at high speeds. It may cause loss in propulsion efficiency. There is a growing need for more and more knowledge as to how propeller hydrofoil sections behave at higher and higher speeds. The problem is to learn how to delay and avoid cavitation or at least live with it. A trip through the labs will underline the fact that everything possible is being done to solve the phenomenon.

Preliminary studies of hydrofoil sections and propellers under controlled pressure conditions are made in the Lithgow Tunnel and the 44 in. water tunnel. Housed in a separate building, the former was moved from Teddington when the Feltham laboratories were erected, the latter was built on the site.

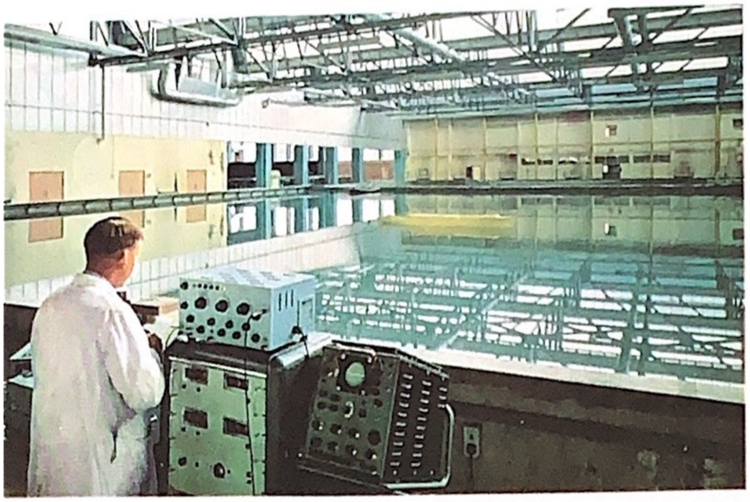
The new water tunnel, one of the largest of its type, is used for research work on propellers up to 24 in. in diameter. When designing it, one of the problems taken into account was maintaining a constant air content in the water. Experience reveals that dissolved air comes out of solution in the low-pressure, high-velocity parts of the circuit. Unless controlled, under such condition, the water is filled with bubbles and the propeller under study cannot be seen. If the air is completely removed, the water is no longer typical sea water.



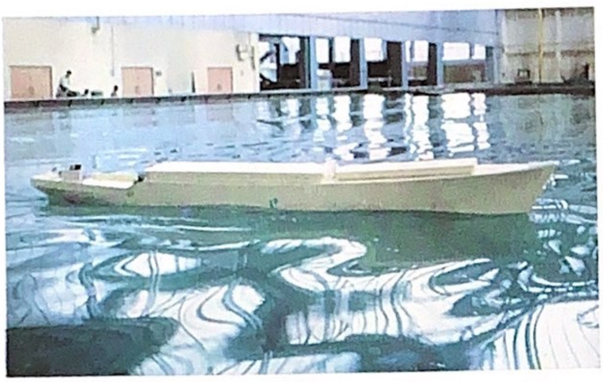
Main tank and towing carriage with hull model under test. Note beach system in tank's opposite shore. Scientists aboard carriage are reading instrumentation to check hull's performance.

Striking high-speed photograph showing how model test hull reacts to man-induced seaway.

Hand-forming a hull model made of wood in the Model Manufacturing shop. Models are also made from paraffin wax and in special cases glass-fibre laminate. This shop has a hull profiling machine for wax and wood.



Maneuvering Tank with model ready for test. Gear foreground remotely controls free-running hull under study. Data from test is either recorded on model or telemetered ashore. Abaft the opposite shore is the Model Storage Tank.



Close-up of a free-running model being studied for its sea-keeping ability.

Model of the Water Tunnel used for propeller and hydrofoil design research. Impeller section is left. Water is taken down 180 ft. below measuring center and subjected to high pressure to keep air content of the water constant.

To beat the problem, engineers designed the tunnel so that air is reabsorbed during each circuit. The process involves taking the water well below the measuring section and there subjecting it to high pressure as it slowly moves through the tunnel.

Actual design of the tunnel shows how this is accomplished. Starting with the test chamber equipped with glass viewing ports, water flows (maximum velocity 50 ft./sec.) via diffusers through a 45° mitered corner into an impeller. The impeller is mounted in a down position and gives a hydrostatic head of 35 ft. From there it runs to a pump, is boosted, then turns another 45° and down through a gradually widening and then near the foot a rapidly narrowing tunnel to a depth of 180 ft. There it turns 90° and flows through a horizontal segment 10 ft. in diameter for 87 ft. Turning 90° again it flows upward to another gradually reducing throat. It then turns 90° to the pre-chamber area before its sharply narrowed prior to entering the test chamber once again.

For the test chamber, model propellers are mounted on a downstream shaft, driven by a 300 hp motor, fitted with torque and thrust dynamometers. Pressures in the test section can be varied from near zero to six atmospheres absolute. Measurements of hydrodynamic performance are made via hydraulic capsules.

In the past, rough water hull tests at the National Physical Laboratory were confined to head-on and stern-on seas. The demand for higher speeds, however, made it essential to ensure that modern ships are designed to maintain these higher speeds regardless of sea and weather conditions. To this end it is necessary to perform model experiments in waves at various angles to the hull and in irregular seas. The new sea-keeping and Maneuvering Tank was designed especially for this job.

The tank is 100 ft. × 100 ft. and has 8 ft. of water. On the south wall is a continuous plunger-type wavemaker capable of producing swells up to 15 ft. long and 9 in. high. Opposite it on the north wall is a beach. Plans are to install a wavemaker on the west wall and a beach on the east wall. This will make it possible to study a model hull's sea-keeping qualities under confused sea conditions.

Sea-keeping investigations are made using remote control models that can be up to 10 ft. long. Considerable ingenuity goes into designing the control and recording equipment used aboard them. It is light, compact and quite reliable. During a test, data from the model's instruments is either recorded aboard or telemetered ashore. Hulls are outfitted with the necessary gear in one of two small docks on the west end of the tank.

Adjacent to the Maneuvering tank is a 60 ft. × 100 ft. storage tank. The end farthest from the larger tank has a channel leading to the launching dock located in the Model and Fitting Shop. Completed test hulls are launched, then stored in the Storage Tank. When ready for testing they are moved to the transfer dock and lifted by an overhead crane to the model Testing Tank.

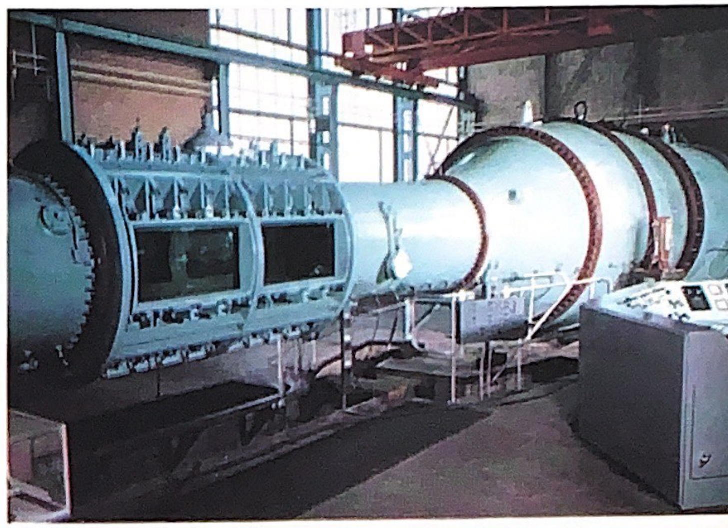
Backing up the test tanks and water tunnels are supporting facilities, viz., a vibration laboratory, instrumentation laboratory and workshops. The vibration laboratory has its own 20 ft. × 14 ft. × 6 ft. tank where studies including entrained water effects are made. Overhead is a grillage designed with a very high frequency to avoid influencing bodies under test.

The Instrumentation Laboratory is an extremely important part of the over-all operation. Here is where the incredible instruments used in all hydrodynamic investigations are developed. It performs two functions: design and development of mechanical and electronic instruments and general calibration and maintenance of instruments.

Last, but not least, are the three large workshops for metalworking, wood-working and model manufacture. All model hulls used in the investigations are built here. Materials used in their construction are paraffin wax, wood, and, in special cases, glass-fibre. To this end there's a wax-melting plant, hull-profiling machines for both wax and wood plus a small well-ventilated shop for work with various types of cellulose and resinous materials.

The metal and woodworking shops are well equipped with standard precision machines for instrument manufacture, patternmaking, etc. Included are special ones used to fabricate propellers. There's also a small foundry and welding shop on hand. Accuracy is the watchword. The skilled craftsmen work to highly exacting tolerances. By doing so, they make the scientist's job that much easier as he puts a hull, hydrofoil or a propeller through various test procedures.

To a layman, the Ship Hydrodynamics Laboratory is at first rather an overwhelming collection of virtually unintelligible gear. But as he is guided through the plant by one of its dedicated engineers, he suddenly captures some of the "spirit of Feltham." This he can hardly avoid. For as the story of what is being done here unfolds, he begins to understand the whys and wherefores behind creating such a fantastic institution. And when he leaves, he does so with a feeling that Britain's shipbuilding industry is indeed lucky to have such capable people and facilities at hand. Their efforts help build better, faster, more economical ships to man England's life-line.



Close-up of Water Tunnel test section. Note narrowing chamber, viewing section and dogging down gear. Instrumentation is at right.

Skilled manual dexterity plays an important part in final finishing a test propeller after it has come from the propeller forming machine.

Striking photograph of a propeller model under test clearly showing cavitation.