Name of organization University of Strathclyde	**Year of information updating** 2022
Year established 1796	**Year of joining the ITTC** Unknown
Address Kelvin hydrodynamics laboratory University of Strathclyde 80, acre road, Glasgow, G20 0TL Scotland, United Kingdom	**Status in the ITTC** Member
Contact details kelvin-hydro-lab@strath.ac.uk Tel: +44(0)141-330-2840.	**Website** https://www.strath.ac.uk/engineering/navalarchitectureoceanmarineengineering/

Type of facility Flow cell	**Year constructed/upgraded** 2018
Name of facility Fully Turbulent Flow Channel (FTFC)	**Location** (Same as above address)

Main characteristics

The FTFC is a closed-circuit flow channel working at atmospheric pressure, with its upper limb located downstream of the main pump acting as the test section and accommodating two test panels at the top and bottom boundaries of the test section. A 3D representation of the FTFC is shown in ***Error! Reference source not found.***-*a*, while ***Error! Reference source not found.***-*b* is an actual picture of the facility. *Table 1* summarises the main particulars of the FTFC upper limb section.

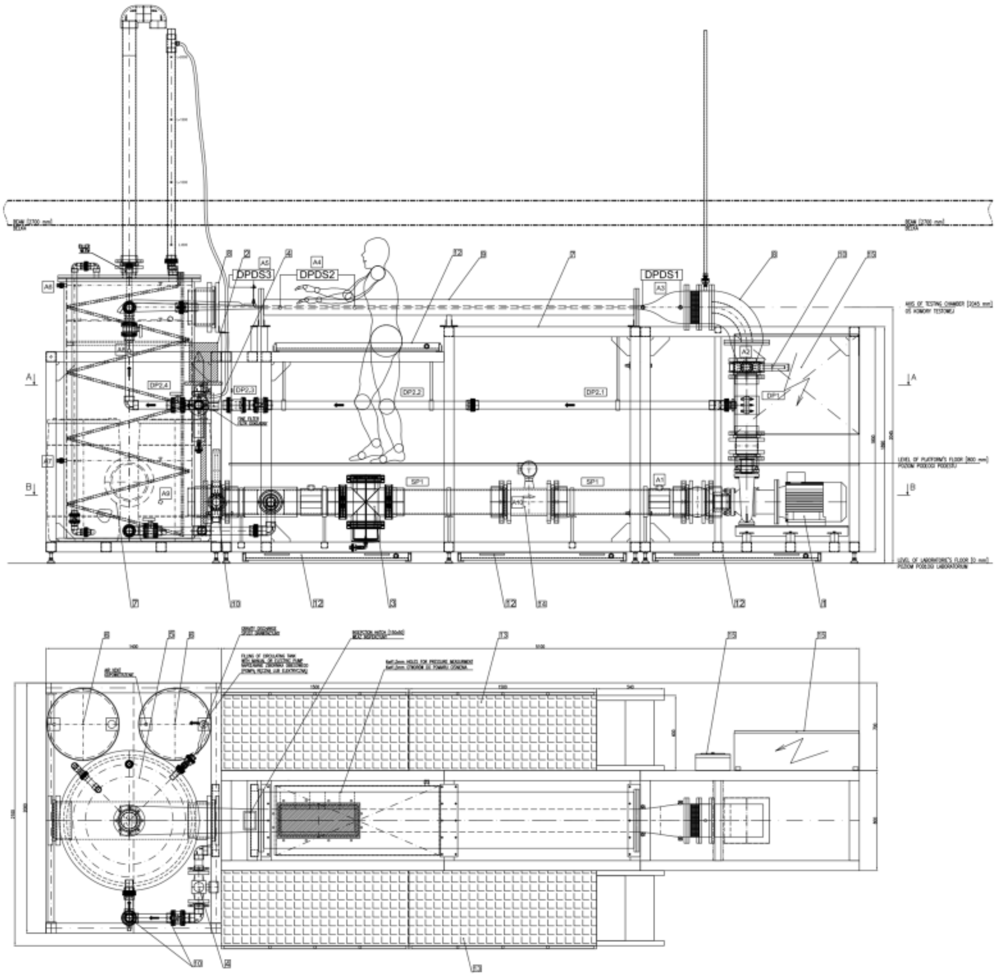
(a) 3D representation of FTFC. *(b) On-site picture of the FTFC.*

Figure 1: Fully Turbulent Flow Channel of the University of Strathclyde.

Table 1: Main particulars of the FTFC upper limb.

Name	Symbol	Unit	Value
Length (Tolerance)	l	mm	$3000\ (\pm 0.05)$
Height (Tolerance)	h	mm	$22.5\ (\pm 0.05)$
Beam (Tolerance)	b	mm	$180\ (\pm 0.05)$
Speed range	U_m	m/s	$2 - 13.5$
Flow rate	Q	l/s	$10 - 60$
Channel height-based Reynolds number	Re_m	-	$0.3 \cdot 10^6$
Material	-	-	Stainless steel (316L)

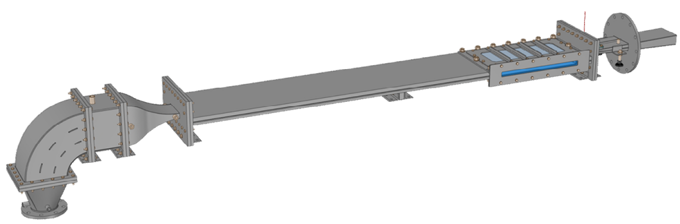
Drawings of facility



Detailed characteristics

With an aspect ratio of 8:1, the FTFC is a high aspect ratio channel that ensures the development of a two-dimensional flow at its test section located at the downstream (tail end) of the upper limb (*Figure 2-a*), where the flow becomes fully turbulent.

(a) 3D representation of the FTFC upper limb.



(b) Top view of the test section accommodating a couple of transparent panels.

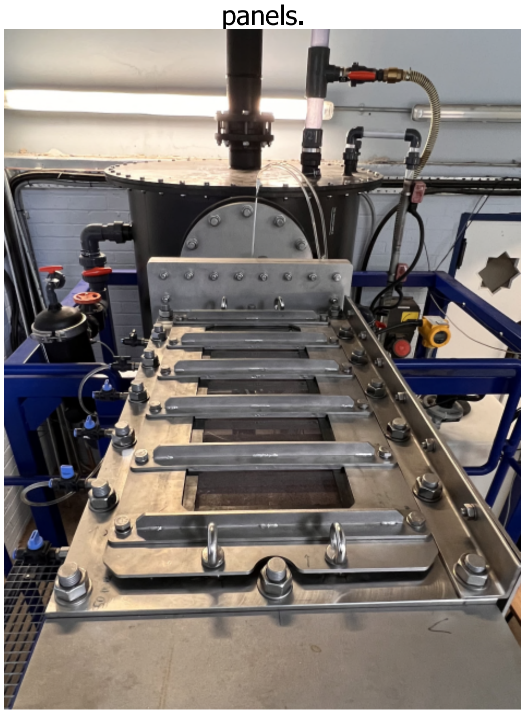


Figure 2: FTFC upper limb.

As shown in *Figure 2-b*, the test section was designed *ad hoc* to accommodate two test panels so that they are flush to the test section's inner surface and avoid gaps and steps that may cause additional undesired vortices in the flow. Also, the test section is equipped with a Perspex side window that allows the use of laser measurement technology, such as Particle Image Velocimetry (PIV) or Laser Doppler Anemometry (LDA). Details of the test section are shown below in (***Error! Reference source not found.***).

Figure 3: Test section equipped with a Perspex side window.

The FTFC is equipped with a magnetic flowmeter situated at the lower limb of the facility (*Figure 4*). The flow rate measured by this sensor is used to calculate the mean bulk velocity of the flow, U_m, with the aid of the test section area and the density ρ of the channel water. The water density, ρ, is specified based on the formulae provided by the ITTC, including the correction for the temperature of the channel flow, which is continuously recorded by the channel sensor. For further information, the centreline velocity is measured at the end of the test section by using a Pitot tube. *Figure 5* shows the pump circulating the flow in the flume. It is a stainless steel 22kW centrifugal pump Grundfos type (noise level less than 80 dbA at max power).

Figure 4: Magnetic flowmeter situated at the lower limb of FTFC.

Figure 5: Centrifugal pump circulating the flow in the flume.

Applications

The efficiency of the hull of a ship is of paramount importance in the evaluation of the overall performance of a marine vehicle, as it is known that skin friction is responsible for the greater part of a ship's resistance. Skin friction depends on the characteristics of the hull surface, including roughness, the surface pattern, coating type and behaviour in different working conditions, biofouling growth and adhesion. Predicting these elements is a fundamental aspect of the design process of marine vehicles, as it has an impact on the choice of the propulsive system, the running costs, and the carbon footprint. For this purpose, the Department of Naval Architecture, Ocean and Marine Engineering (NAOME) of the University of Strathclyde (UoS) designed and had commissioned the construction of a state of the art Fully Turbulent Flow Channel (FTFC) to simulate the turbulent flow around a ship and evaluate the performance of marine coatings (as applied or biofouled), mimicked biofouling, and surface patterns such as riblets, tubercles, etc.

Published description

Marino, A.; Shi, W.; Atlar, M.; Demirel, Y.K. Design Specification, Commission and Calibration of the University of Strathclyde's Fully Turbulent Flow Channel (FTFC) Facility. In Proceedings of the 6th International Conference on Advanced Model Measurements Technologies for The Maritime Industry (AMT'19); Rome, 2019.