

Turbine loading and performance data for three SupeGen UKCMER Tidal Turbines in a closely spaced staggered array at FloWave

Introduction

This dataset presents a set of turbine loading and performance measurements carried out at the FloWave Ocean Energy Research Facility, around a closely spaced staggered array of three nominally 1:15 scale tidal turbines, with a 1.2m rotor diameter (D), shown in Figure 1. The array comprised two front turbines separated by 3D centre-to-centre. A primary turbine (red fairing in Figure 1) was mounted centrally between these, 1D downstream. Flow velocity in the tank was nominally 0.8m/s for all tests. The set of tests are described fully in [1]. Each of the turbines are instrumented, and were produced under the SuperGen UK Centre for Marine Energy Research (UKCMER) project. The detail and construction of this type of model turbine are described in [2].

The primary (rear) turbine was instrumented to measure streamwise root bending moment in each blade, drive shaft torque, thrust on the rotor, and angular velocity of the rotor. The two front turbines were only instrumented with torque and thrust sensors for these tests. Measurements from all the sensors were logged at 256Hz.

The tests comprise two array configurations, with one and three turbines installed in the tank, as detailed in Table 1. The position of each turbine in the array was kept constant throughout. The front and rear turbines were operated using speed control for a range of RPMs as shown in Table 2.

A related dataset from this set of tests contains spatially distributed point measurements of flow for selected turbine rotational speeds. [3]

Table 1: Details of array configurations used in tests

Configuration	Number of turbines	Details
AC1	1	Primary (rear) turbine only
AC3	3	Full three turbine array

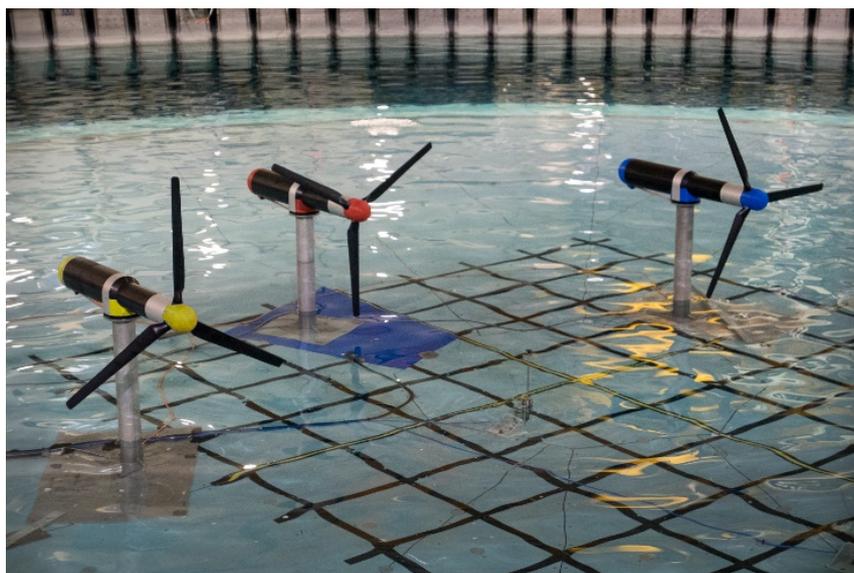


Figure 1: photograph of all turbines installed in FloWave.

Table 2: Details of turbine rotational speeds used in tests

Primary Turbine RPM	Front Turbines RPMs
39	Not installed
45	Not installed
51	Not installed
58	Not installed, 58, 71, 90
64	Not installed, 58, 71, 90
71	Not installed, 58, 71, 90
77	Not installed, 58, 71, 90
84	Not installed, 58, 71, 90
90	Not installed, 58, 71, 90
96	Not installed, 58, 71, 90
103	Not installed, 58, 71, 90
116	Not installed
128	Not installed
141	Not installed
154	Not installed
167	Not installed

Description of data files

Data files contain the variables as shown in Table 3, and are named as follows:

- AC1_P##rpm.csv – where P## is primary turbine rpm
- AC3_P##rpm_F##rpm.csv – where P## is primary turbine rpm and F## is front turbines rpm

Table 3: Details of columns in data

Column	Variable	Details
1	Time	[seconds]
2	RBM0	Root bending moment (blade0) [Nm]
3	RBM1	Root bending moment (blade1) [Nm]
4	RBM2	Root bending moment (blade2) [Nm]
5	Torque	Torque on primary turbine rotor drive shaft [Nm]
6	Thrust	Thrust on primary turbine rotor [N]
7	Angular Velocity	Measured rotational speed of primary turbine rotor [rpm]
8	Torque (Front)	Torque on one front turbine rotor drive shaft [Nm] (AC3 only)
9	Thrust (Front)	Thrust on one front turbine rotor [N] (AC3 only)

References

- [1] D. R. Noble, S. Draycott, A. Nambiar, B. Sellar, J. Steynor, and A. Kiprakis, "Experimental Assessment of Flow , Performance , and Loads For Tidal Turbines in a Closely-Spaced Array," *Energies*, vol. 13, no. 1997, Apr. 2020. DOI: [10.3390/en13081977](https://doi.org/10.3390/en13081977)
- [2] G. S. Payne, T. Stallard, and R. Martinez, "Design and manufacture of a bed supported tidal turbine model for blade and shaft load measurement in turbulent flow and waves," *Renew. Energy*, vol. 107, pp. 312–326, Jul. 2017. DOI: [10.1016/j.renene.2017.01.068](https://doi.org/10.1016/j.renene.2017.01.068)
- [3] D. R. Noble *et al.*, "Flow data around three Supergen UKCMER Tidal Turbines in a closely spaced staggered array at FloWave," *Edinburgh DataShare*. The University of Edinburgh. School of Engineering. Institute for Energy Systems, Edinburgh, UK, 2020. DOI: [10.7488/ds/2762](https://doi.org/10.7488/ds/2762)