CATAPULT
Offshore Renewable Energy

Levenmouth Development Turbine

Measurement System Signals

May 2016

Contents

1 SCADA System

1.1 Data Recording and Reporting Structure

The Levenmouth Development Turbine uses a commercial package for archiving and reporting of SCADA data – GH WindHelm.

Data is acquired from turbine control subsystems (such as the Main PLC, Converter and Pitch Systems) using a bespoke hardware interface known as a RIU. The RIU timestamps are centrally monitored by the SCADA Server to maintain synchronism of the data from the various subsystems.

Data is recorded on the SCADA server and can be provided in timestamped Comma Separated Variable Files. **All data is recorded at 10 minute intervals**.

Standard Mean, Maximum, Minimum and standard deviation statistics are calculated for all analogue signals. Directional signals are processed using vector averaging.

1.2 Data Available

The SCADA System states that it contains data from 00:00 on 10/04/2014, however SCADA systems are known to not have 100% data availability for their full operating period. SCADA data is still being captured.

1.3 Signals Available

Below table summarises the monitoring sensors

Item	Description
Ambient conditions	Air temperature, smoke detector, Wind direction and speed
Grid monitoring/ Power level	Voltage, current, power, frequency (PR in switchgear)
Gearbox	Oil level sensor, temperature sensors, pressure sensors
Generator	PT100 elements for bearings and stator winding (incl. spare) Lubrication failure alarm
Blade	Sensors for stress monitoring installed near blade root
Yaw & pitch system	Profibus communication (position, temperature and so on) Hard-wired safety chain
HPU (Hydraulic Power Unit)	Oil level, pressure and temperature
ALS (Auto Lubrication System)	Oil level, distributor activation
Rotor brake	Engaging indicator
Nacelle temperature	Nacelle inside / outside (PT100)

1.3.1 Wind Data

Wind data is available from the IEC met mast installed on site and consists of data from:

- 4x Thies “First Class” rotating cup anemometers
- 2x Mechanical Wind Vanes
- 2x Temperature sensors (top and bottom of mast)
- 2x Air Pressure Sensors (top and bottom of mast)

Wind data is also available from the turbine anemometers, but this data is only useful as a reference as to the input variables of the control system.

1.3.2 Blades

Each blade contains an array of 4, individually temperature compensated, Fibre Bragg Grating strain gauges installed axially approximately 2m from the root of the blade. These are connected to an Insensys Moog Optical Interrogator.

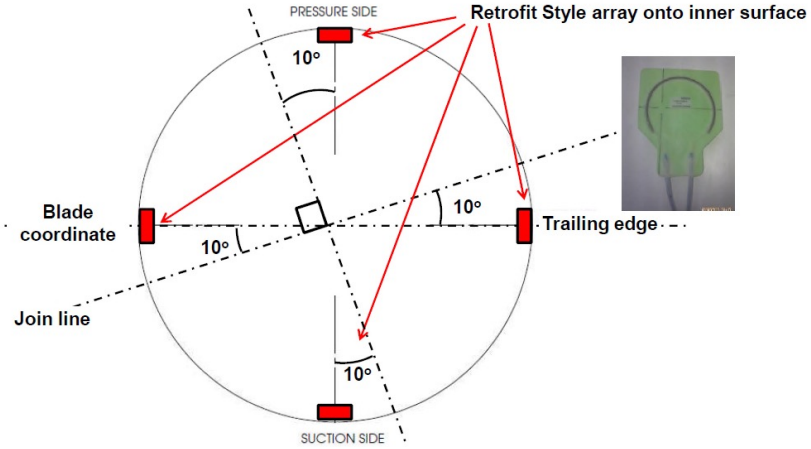

Figure 1 - Blade Root Strain Gauges installation diagram

These sensors underwent a level of in situ calibration as part of their installation.

1.3.3 Pitch System

Each blade has an independent “axis” controller complete with encoders and electrical drives. These report:

- Pitch Position
- Pitch Rate
- Pitch System Status

1.3.4 Main Rotor Bearing

The main rotor bearing has monitoring for:

- Temperature (2x)

- Deflection with reference to Lantern frame (4 cardinal points) using eddy current sensing
- Vibration (2x)

1.3.5 Gearbox and associated Lubrication System

The Lubrication system supplies oil to both the Gearbox and Main Rotor Bearing, and contains sensors for:

- System Temperature (in and out flow)
- Oil Contamination

Additionally, gearbox oil is sampled as part of the standard service regime.

The gearbox contains additional sensing for:

- Shaft bearing temperatures
- Temperatures of internal bearings
- Vibration

1.3.6 Generator and Power Converter Systems (including MV Transformer)

The Generator is directly connected to an ABB PCS6000 fully rated converter which is situated near the base of the tower. Signals available from this system are:

- Generator mounting deflection (4 locations)
- Generator Stator temperatures (6 locations)
- Generator Bearing temperatures (4 locations)
- Phase Voltages and Currents (Generator out, Converter out, Transformer out)
- Active and Reactive Power
- Frequency
- Power Factor

1.3.7 Tower

The tower contains the majority of the turbine Balance of Plant including the MV Transformer and Power Converter.

Vibration in the fore/aft and side/side directions are recorded and monitored.

2 Condition Monitoring Systems

In addition to the SCADA System, the turbine contains a number of higher specification Condition Monitoring Systems for the Blades, Gearbox, and Converter. These were not configured to record data continuously due to the high data volumes which would be created, however ORE Catapult are in the process of installing servers at the Levenmouth site to allow the data to be recorded. The design of CMS meets accepted guidelines:

- IEC 61400_22
- GL Guideline of CMS for wind Turbines, Ed. 2013

2.1 Data Recording and Reporting Structure

These systems contain bespoke recording subsystems, and initially data may only be available in the native system format. Experience of the Insensys OEM blade monitoring system suggests that the files can be converted to CSV format.

2.2 Data Available

All of these systems are physically installed on the turbine, and other than a small amount of work to set up data storage systems, are otherwise ready for use. There is currently no data available for these systems.

2.3 Signals Available

2.3.1 Wind

A Campbell Scientific CR1000 data logger has been installed into the met mast junction box with the aim of recording the anemometer data at 1Hz. This work is currently ongoing on site. Data will be available in .DAT format, which can easily be imported into Excel etc.

2.3.2 Blades

In addition to the Blade Root strain gauges, one of the blades is fitted with a number of strain measuring elements as shown below:

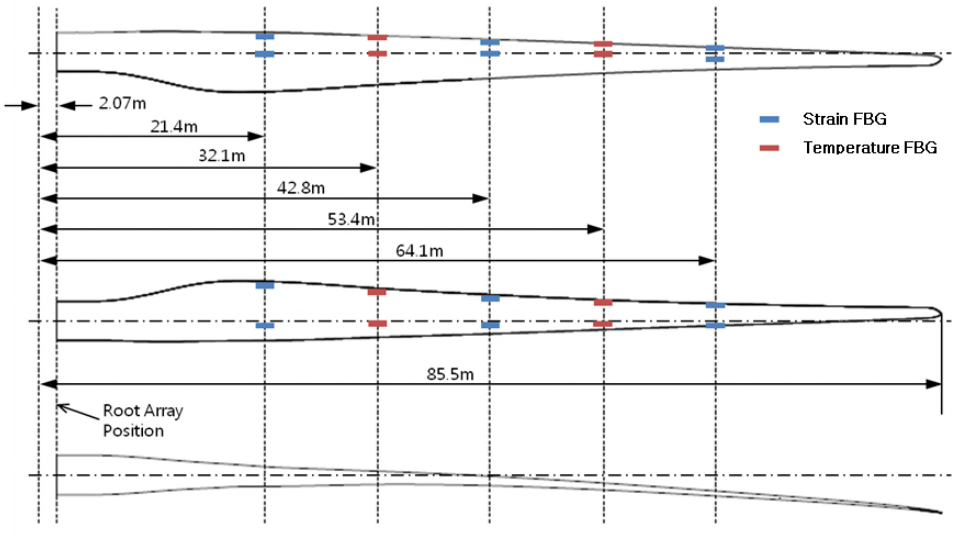

Figure 2 - Blade Strain Gauge Array

As shown, there are Strain Measuring and Temperature Compensating elements.

2.3.3 Main Rotor Bearing, Gearbox and Generator

A GE/Bentley Nevada Vibration Monitoring system is installed on the turbine with indicative vibration measurements at each stage in the gearbox, as well as on the MRB and Generator.

2.3.4 Converter

The ABB PCS6000 contains a number of high speed monitoring tools for recording voltage and current waveforms. OREC are investigating how these can be archived over a longer term to look at AC input and output waveforms as well as the DC bus.

3 Questions

For any question or clarification related to the data in the context of the Supergen Flexible Funding call (May 2016) please contact Ross Fleming who will compile and send them to ORE Catapult.

Access to the data is subject to the signature of a data sharing agreement with ORE Catapult.

Contact

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