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ARRAY CABLE MONITORING SYSTEM

CASE STUDY

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1.0 Overview

Dynamic Load Monitoring (UK) Ltd were approached by Subsea Innovation to develop a monitoring system, which was able to gather information on the stresses and movement experienced by array cables interconnecting the Wind Turbines on London Array wind farm off of the coast of Kent in the UK.

Figure 1: London Array Wind Farm (Kent, UK)

The Problem:

Over time the array cables which enter the wind farm platform via the bell mouth in base of the turbine platform, had been subject to movement and had been at the risk of fatiguing under the constant movement and flexing. This is a major concern as a broken array cable not only results in disruption to the supplied power output of the wind farm, but also result in costly repairs needing to be undertaken.

In order to mitigate the risk of the cables failing, Subsea Innovation designed a Dynamic Bend Stiffener to strengthen the cable entry point. In order to determine if this solution was to work in practice a trial would need to be undertaken with the Bend Stiffener in place, with the movement and stresses applied to the Stiffener measured and recorded over time.

The Solution:

DLM were approached to design Load Pins which would fit on the frame work securing the Bend Stiffener in place and also provide accelerometers which could monitor the movement of the Stiffener over a period of time. This information would need to be data logged at a rate of 10Hz (10 times per second), recorded and collated on the turbine. All sensors were connected to a PLC system which allowed remote access by the client, London Array.

2.0
The System

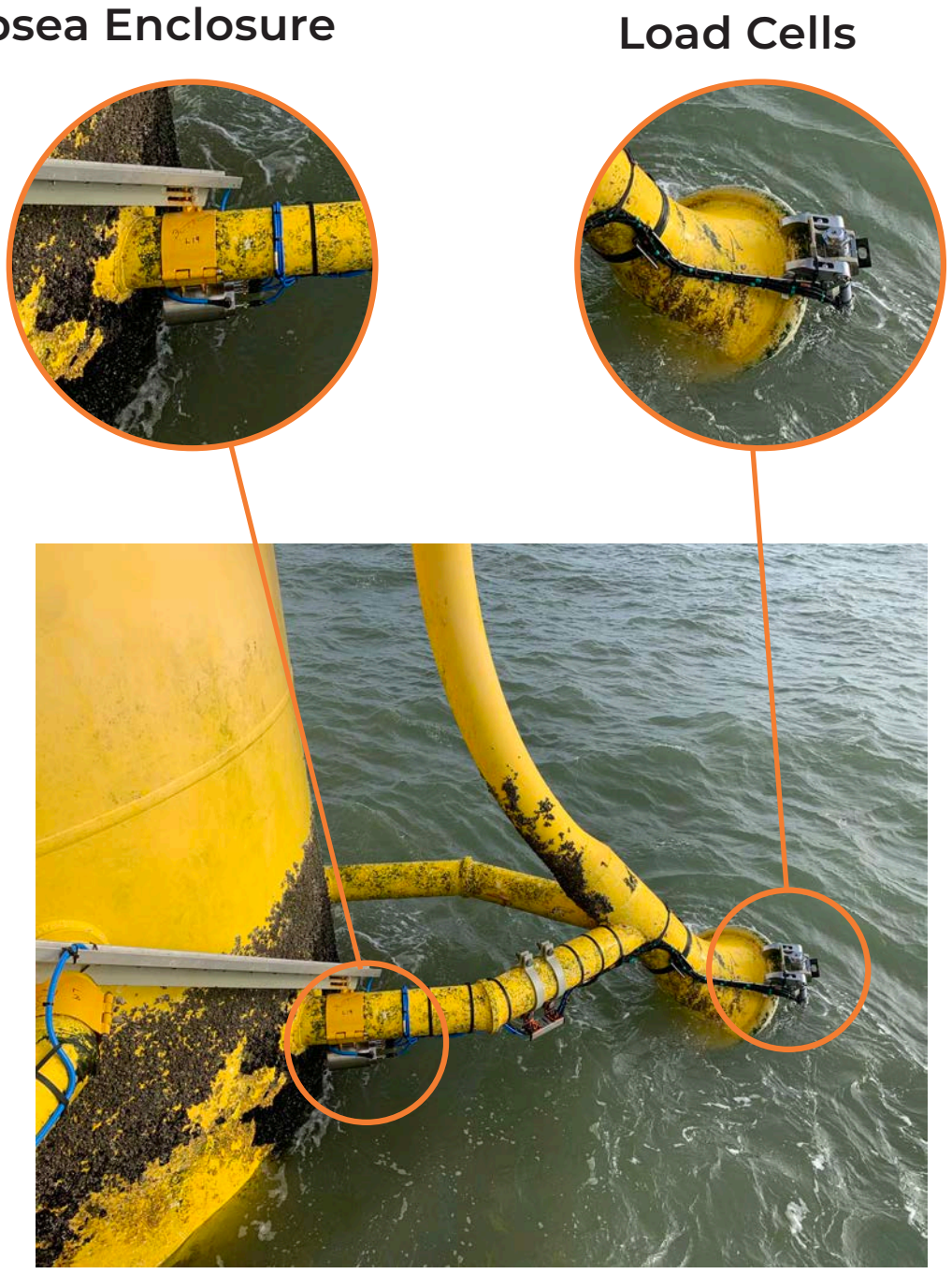
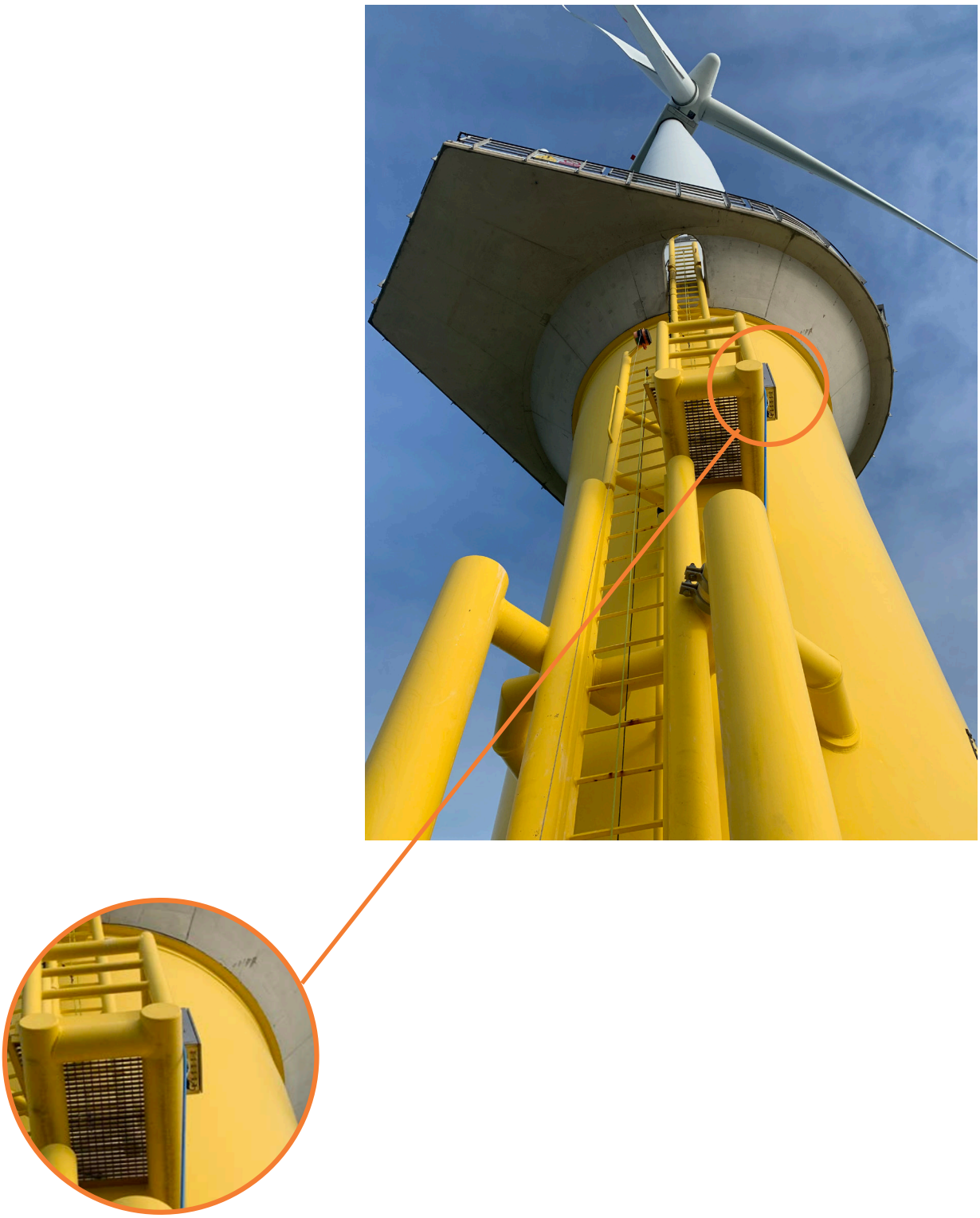


Figure 2: Subsea Enclosure and Load Cells,
London Array Wind Farm (Kent, UK)

Figure 3: PLC Enclosure,
London Array Wind Farm (Kent, UK)



PLC Enclosure

3.0
Load Cells

Load Cells

DLM Design Engineers utilised their expertise in the manufacture of Subsea Load Pins to design three Dual plane bi-directional Load Pins rated to ±40kN each. The Load Pins were able to measure loads in both X and Y load planes, as shown in fig 1 below, and also measure load in the positive and negative direction in both planes. This enables stresses in multiple directions to be measured when the Load Pins are located in the securing clamps around the circumference of the Bend Stiffener.

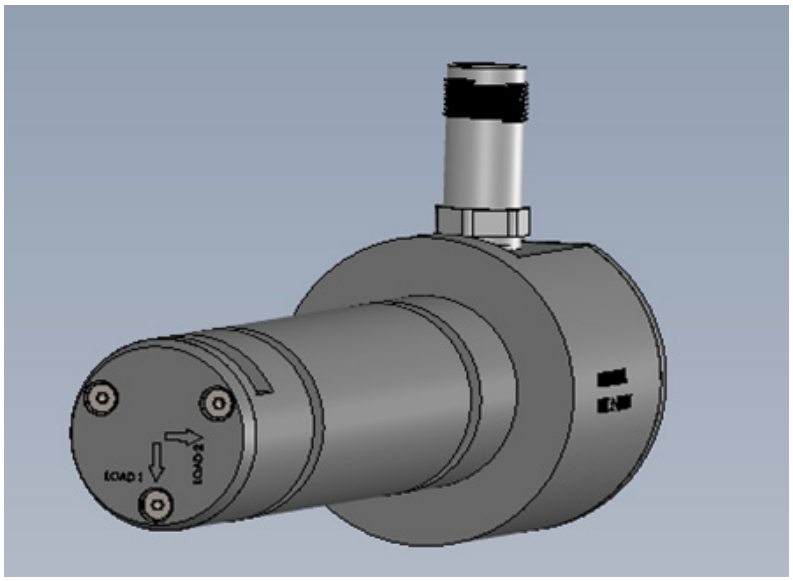


Figure 4: Load Pin, DLM

Each Load Pin was fitted with two internal 4-20mA signal conditioners which were scaled to each of the Load planes (X and Y), such that 4mA = -40kN and 20mA = +40kN. The Load Pins are fitted with metal shell subsea rated connectors which mate with metal shell subsea connectors, over moulded on high quality shielded twisted pair cable. The signal cables power the load pins with 24VDC originating from the PLC enclosure, via the local subsea junction box, while also carrying the 4-20mA signals to the data loggers..

Subsea Accelerometer / Data loggers

In order to measure the movement and angular rotation of the array cables Bend Stiffener, DLM utilised the recently developed multi-functional Data logger DL-3.0, which contains an on-board accelerometer and inclinometer, all packaged in a DLM designed subsea enclosure.

The DL-3.0 is a Load Cell data logger able to log the data being received from a Load Cell output (either mV or mA) at user adjustable sampling frequencies ranging from 800Hz to once per hour. However, the DL-3.0 has the added ability to measure the acceleration in ranges of ±2g, ±4g, ±8g or ±16g and, also output a live RS232 string of the logged data. It boasts other features like on-board GPS capability and future Bluetooth connectivity (which is not yet enabled), but these features were not utilised in this particular project.

Figure 5: Subsea Data Logger, DLM

In this application two Subsea Data Loggers were located at different positions on the Bend Stiffener and, were connected via subsea over moulded cables to the Subsea Junction box located on the secondary steel above the Bell Mouth. The data gathered from the on-board accelerometers was stored locally on the DL-3.0's memory card and transmitted live via an RS232 serial string.

Subsea Junction Box

Located on the secondary steel above the Bell Mouth, DLM designed a stainless steel subsea rated junction box which would locate a further six DL-3.0 Data Loggers, which were used to record the loads sensed by X and Y planes of each of the three Load Pins. Within the junction box, all of the live RS232 outputs from each sensor, 3 load cells and 2 inclinometers, was sent via single multi-core cable up to the PLC cabinet.

The serial string is sent to the PLC enclosure via subsea rated cable and once again metal shell subsea rated connectors, for maximum protection against the rugged environment. The enclosure is provided with 24VDC power from the PLC enclosure, which is located just below the turbine platform.

Figure 6: Subsea Junction Box, DLM

PLC Enclosure

Located below the turbine's access platform is hub of the system, the PLC Enclosure. This device consists of a Siemens ET200 PLC with I/O modules allowing connection to the subsea junction box via multiple RS232 serial strings, whilst also providing a source for the 24VDC power supply to the whole system.

The industrial PLC is programmed to interrogate all of the data loggers associated with each Load Cell and both Accelerometers, providing a hub for all of the collated information and offering a gateway to all of the data logger information.

The PLC has a fixed IP address and the enclosure is fitted with an IP68 Ethernet port which enables remote access when connected to a network with internet access. By setting up the PLC on the VLAN, the client is able to remotely monitor and analyse the data, along with downloading data logged information and checking the status of the system.

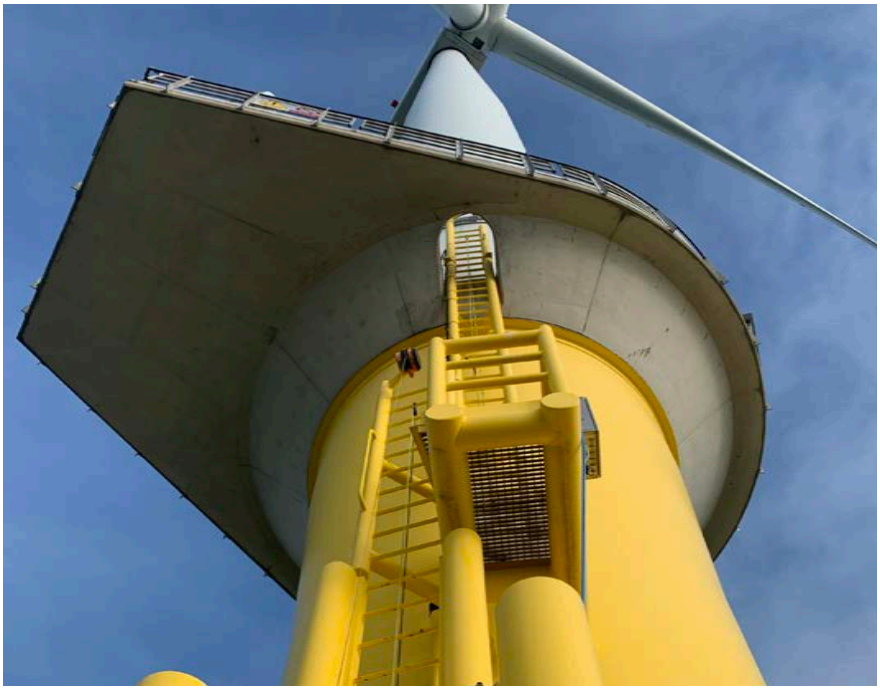


Figure 7: PLC Enclosure, London Array Wind Farm (Kent, UK)

4.0
DLM Software

Remote Access

Remote access to the PLC, and ultimately the data logs, is made possible by setting up a connection to the PLC via a VLAN and the turbines local network. This allowed the maintenance team to download logs and monitor the system from the shore by using a custom web-viewer on any PC within the network. The data is presented in the form of a remote HMI screen, showing the load on the array cable measured by the Subsea Load Pins and the movement measured by the Subsea Accelerometer / Data loggers mounted on the Bend Stiffener. All of the data was collated into a single CSV file, showing the readings of each sensor on a single time stamp.

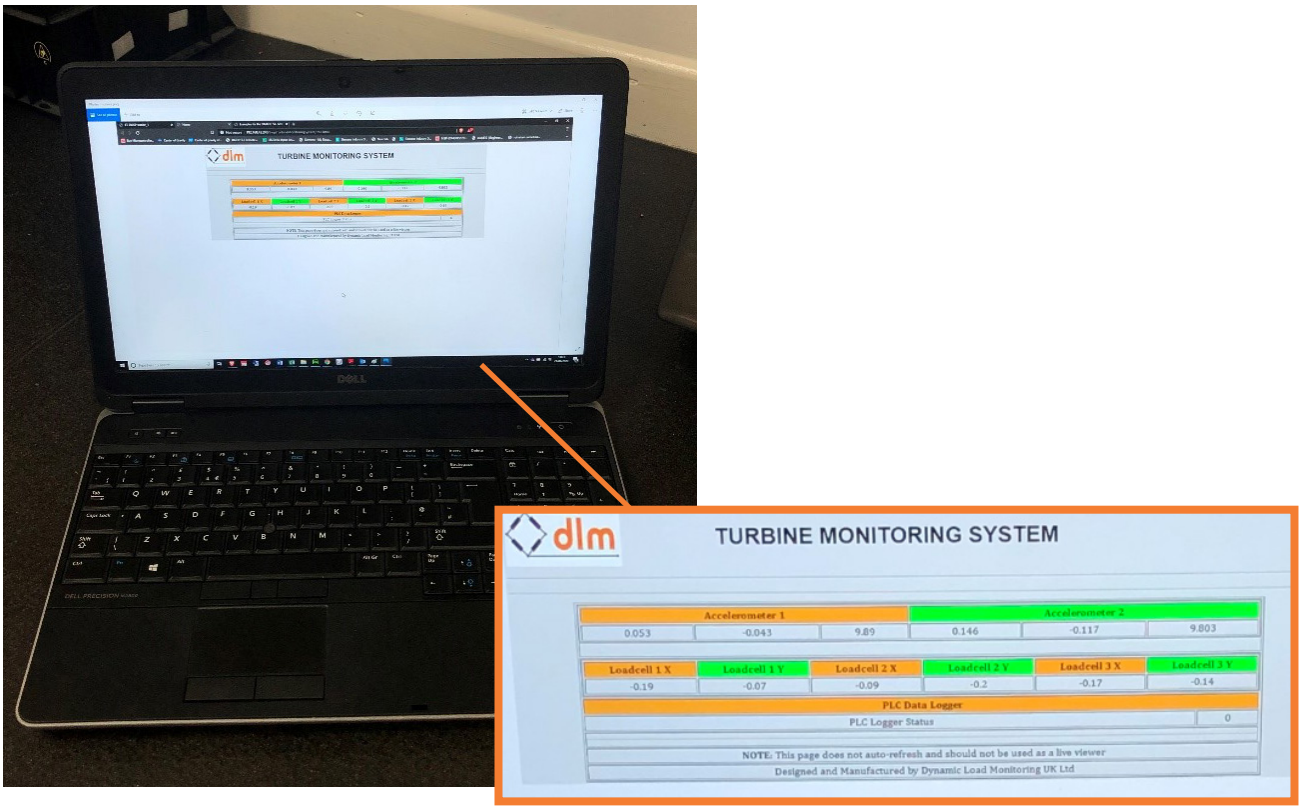


Figure 8: Remote Access, DLM

5.0 Installation

Installation and Commissioning

The install of the system was completed utilising a work boat and dive team to install the Load Cells and Accelerometers on the Bend Stiffener. Access to the turbine via a CTV allowed DLM's offshore trained Engineers to commission the instrumentation and to assist with the final setup, ensuring the system performed as expected.

Figure 9: London Array Wind Farm (Kent, UK)

Figure 10: London Array Wind Farm (Kent, UK)

6.0
Contact

Contact Details

If you're interested in this case study and would like to enquire about any of the products mentioned or the offshore installation from our trained engineers, please get in touch with us at sales@dlm-uk.com.

Otherwise, please check out our past case studies and editorials on our website at www.dlm-uk.com.

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