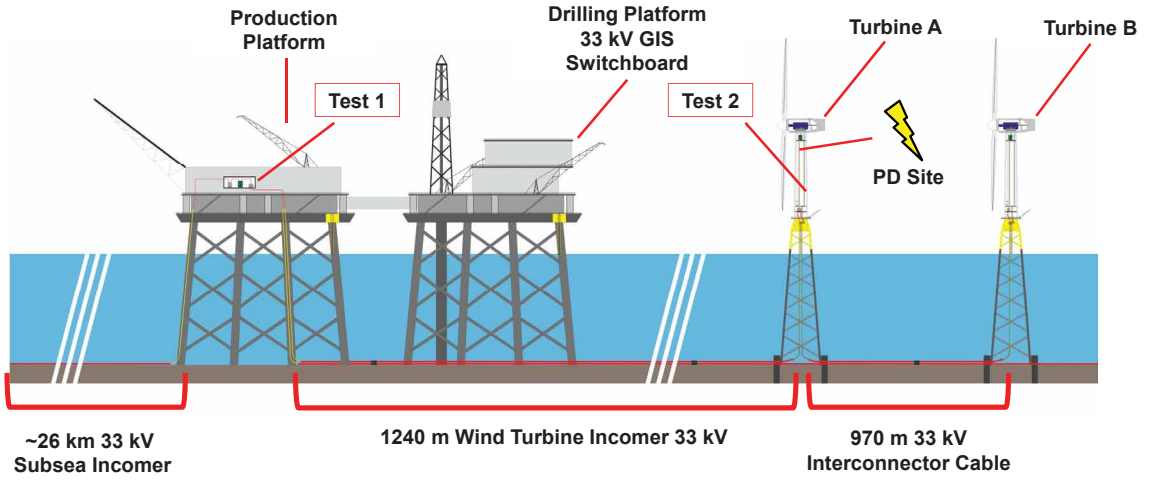
OLPD Testing and Fault Location on 33 kV Offshore Wind Turbine Subsea Cables from an Oil Platform

CASE STUDY

- 33 kV Cable Feeder
- Oil & Wind Industries
- HFCT Sensors
- Cable Mapping

Project

An ***offshore oil production platform in the UK North Sea*** requested on-line partial discharge (OLPD) testing on their ***offshore 33 kV network***, including the ***33 kV subsea export cable*** from two (2) deep water experimental offshore wind turbines to a main oil production platform, as shown in the diagram below. Turbine A was connected via a 1240 m cable and Turbine B via a further 970 m, to make a ***total 33 kV circuit length of 2210 m.***



33 kV Oil Production Platform with two (2) Offshore Wind Turbines Connected by a 33 kV Subsea Cable Network

Solution

OLPD Test 1 was carried out at the 33 kV ***gas insulated switchboard (GIS)*** at the main production platform using the **HVPD Longshot™ test unit** with a ***combination of HFCT and TEV sensors*** attached to each phase of the cable at the earthed terminations. This first test measured the PD up to and including the 33 kV ring main unit (RMU) located at the bottom of the Turbine A Tower, 1240 m away. ***OLPD Test 2*** was then carried out at the ***RMU at Turbine A*** to pinpoint the location of the PD source that was detected in OLPD Test 1, using ***TDR pulse timing*** measurement techniques as described below.

Tests

OLPD Test 1 was carried out at the 33 kV GIS on the main platform. The results in the Table below show ***significant 'remote' PD*** activity (of up to 6.33 nC) was detected on the yellow phase of the 33 kV cable ***from the Wind Turbine A platform.***

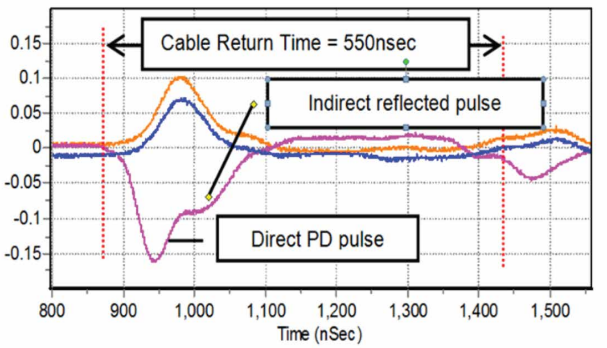
Test & Description	PD Peak (nC)	Comment
Test 1 - 33 kV Incomer B Phase	**2.41**	Blue Phase - *crosstalk from yellow phase*
Test 1 - 33 kV Incomer Y Phase	**6.33**	**Yellow Phase** – ***PD Source (at the remote end of the cable)***
Test 1 - 33 kV Incomer R Phase	**2.27**	Red Phase - *crosstalk from yellow phase*

OLPD Test 1 at Main Platform GIS - OLPD Test Results

On-line Time Domain Reflectometry (TDR) testing using low-voltage, on-line pulse injection ***via inductive HFCT sensors*** was carried out on the 33 kV incomer cable from the wind turbines. Pulse timing measurements of the reflections of the injected pulses (from impedance changes along the circuit) was then used to pinpoint discharging site(s) along the circuit. These TDR tests also enabled the ***Return PD Pulse Speed (RPPS)*** of the cable to be calculated. In this case the ***RPPS for this 33 kV cable was 92.1 m/µsec.***

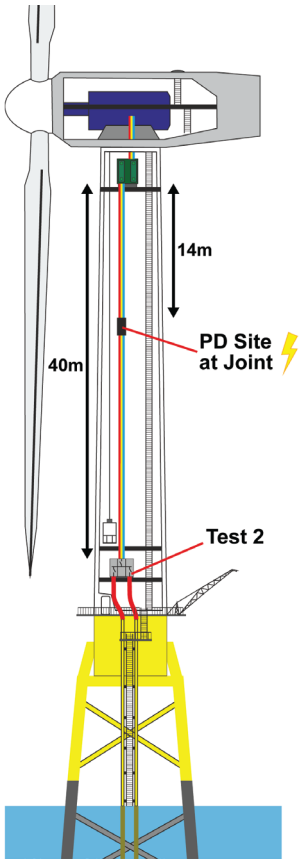
HFCT Sensors on Tower A RMU 33 kV cable

OLPD Test 2 was carried out at the 33 kV ring main unit (RMU) at the base of the wind turbine A platform using HFCT sensors connected around the cable and the earth return of each phase, as shown opposite. This test ***pinpointed the source of the PD to a cable joint/splice*** 26 m up from the RMU, ***14 m from the 33 kV transformer*** at the top of the tower, as shown below.



OLPD Test 2 – PD site pinpointing test waveforms and data

Phase	*First Reflection (ns)*	*40m Cable Section Return Time (ns)*	*PD Location (m)*
Yellow	152	431	14
RPPS for Cable = 92.1 m/µsec, Cable Return Time = 431ns			
PD Location (from 33kV Transformer) = 92.1 x 0.152 = **14m**			



Conclusions and Recommendations

- OLPD Tests 1 and 2 detected then pinpointed a significant amount of PD activity from a ***33 kV cable joint/splice*** 14 m from the 33 kV transformer at the top of the Turbine A Tower. The 33 kV joint was replaced and the diagnostic OLPD tests carried out after replacement showed the PD source had been removed.

- It can be noted that the discharging joint/splice ***was not part of the original design*** but was included due to the cable being short when it was 'pulled in' (this being a common occurrence). The root cause of the discharging joint was ***insufficient mechanical stress relief and fastening of the cable to the cable joint/splice*** with the weight of 26 m of vertical cable pulling apart and stretching the 33 kV insulation inside the cable joint/splice producing partial discharge and tracking.

- For remote, critical HV networks such as this offshore platform in the UK North Sea, HVPD recommend the installation of a ***permanent HVPD Kronos® OLPD monitoring technology*** with ***expert OLPD monitoring engineering service.***

Certificate Number 9329
ISO 9001, ISO 14001, OHSAS 18001

HVPD Head Office
128 Metroplex Business Park
Broadway, MediaCityUK
Salford, M50 2UW
United Kingdom

+44 (0)161 877 6142
+44 (0)161 877 6139
info@hvpd.co.uk
www.hvpd.co.uk