Best Practice Guideline for the Complete Condition Monitoring (CM) of Offshore Wind Farm (OWF) Cable Networks

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ABSTRACT

The paper presents an overview and 'best practice guidelines' for the condition monitoring of off-shore windfarm cables from installation and commissioning through to service life. Measurements of online partial discharge (OLPD), power quality (PQ) parameters, sheath current (SC) are combined to provide a 'holistic' condition monitoring technique to assess the online condition of export cables and inter-array network.

This work presents the experience and knowledge gained developing a holistic electrical condition system dedicated to offshore windfarms.

KEYWORDS

Online Partial Discharge Monitoring, OLPD, Sheath Current Monitoring, Offshore Wind Farm, Inter-Array Network, Power Quality, Condition Monitoring,

INTRODUCTION

Offshore wind farm (OWF) operators need accurate, detailed (real-time) information on the state, condition and performance of offshore high voltage (HV) networks. This diagnostic intelligence is essential to maintain high reliability and availability and achieve the significant reductions in operating/maintenance costs required into the future. This paper reports the results and knowledge gained during an 18 month project to develop an integrated offshore high voltage network management system (OHVMS) for windfarms through a collaboration led by HVPD Ltd including several industrial and accademic partners.

The drive is to support condition-based management (CBM) schemes to help improving maintenance practice and drastically reduce operational costs since:

- The UK offshore wind farm industry has (to date) suffered a higher-than-expected number of medium voltage (MV) and high voltage (HV) cable faults.
- The Insurance Industry has reported that MV/HV cable faults presently make up over 80% of UK offshore wind farm insurance claims with many faults occurring during the construction and commissioning phase [1].
- The UK Government (DECC) have stated that they require the (presently high) Levelised Cost of Electricity (LCOE) over the 20-year lifetime of the asset to fall by 25% by 2020 to make offshore renewables electricity more affordable[2] [3] [4].

It is argued that a radical rethink of existing offshore MV and HV cable network asset management practices is needed to achieve this through the use of better, diagnostic commissioning testing and 'holistic' condition monitoring (CM) solutions for in-service cables.

Initially the drives behind the use of CM will be explained introducing the needs for a multi-parameters CM system developed specifically for OWF. The paper then summarises some of the parameters to be monitored and presents the proposed 'Best Practice Guidelines'. Finally the OHVMS system developed is presented with a case study.

The OHVMS is a highly innovative system, that combines online partial discharge (OLPD) condition monitoring (CM) technology, with additional sheath current (SC) and power quality (PQ) CM technologies.

CONDITION MONITORING OVERVIEW

Good equipment maintenance consists of identifying any issues through the "bedding in" phase and then overhauling (or replacing) it before it reaches the wear-out phase. An extended and more conscious maintenance strategy could be focusing on extending the life of the equipment.

- This is accomplished by monitoring and detecting degrading conditions in each phase of the bathtub curve, see Fig. 1. Bedding in phase: good quality control could reduce the failures related to the defects introduced during the manufacturing process of the assets and their installation.
- Steady State phase: commissioning/acceptance tests could reduce the failures related to the defects that would occur during the normal life of the asset, but earlier than can be reasonably be expected.
- End of life phase: spot testing/continuous monitoring could reduce unplanned faults related to the degradation of the insulation itself. Diagnosing any incipient faults and coordinating and directing repair actions could extend the life of the assets.

It should be noted that it is largely assumed failure rates on off-shore windfarm cables will follow this path as cables have not yet been left installed for their predicted service life.

This theory can also be visually reassumed by Fig. 1.