On line PD Monitoring of Short Cable Systems Installed in Substations

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ABSTRACT

Short cable systems to connect power transformers with GIS are rarely tested during commissioning tests. Special cable terminations must be used to remove the electrical connections with the power transformer. Furthermore, the low capacitance of these short cables requires special resonant generators. However, an insulation failure in a cable termination installed in a power transformer can be very critical. This paper describes a complete on-line PD monitoring system for short cable systems used in substations that permits to perform synchronized PD measurements using PD sensors placed on the earth connections of the cable and of the transformer.

KEYWORDS

PD monitoring, insulation condition, PD clustering, PRPD pattern; UHF PD sensors; HFCT PD sensors

1. INTRODUCTION

Commissioning tests on short cable systems installed in substations using conventional mobile generators are very complicated. Special cable terminations to remove the electrical connection with the power transformer are required. Furthermore, low capacitance of short cable systems requires higher inductors than the ones of usual resonant generators to get an appropriate resonance frequency [1, 2]. The best testing method to perform PD measurements in the same conditions that the substation operates is using a mobile high voltage generator of frequency higher than 100 Hz supplying the testing voltage through a MV winding of the substation power transformer and compensating the reactive power by means of inductors. However, in many cases, neither commissioning tests nor periodic PD tests are performed on these short cable systems, in spite of the critical consequences that can be originated by an insulation failure in a cable termination installed in a HV substation. The dielectric insulation health is very important not only for the equipment integrity but also for safety reasons.

Therefore, on line PD measurements of these short cables are very convenient, although some technical issues must be properly solved to get efficient insulation diagnosis: a) interference noise level on substations are often very high, therefore the electrical noise must be discriminated from the PD pulses, b) many different PD sources can be detected, consequently the equipment causing PD sources must be identified (cable termination, voltage and current transformers, power transformers, surge arresters, insulators, bus bars), c) different PRPD patterns must be distinguished and associated to each cause (corona, external insulation surfaces, defect in dielectric media, etc.).

This paper describes a complete on-line PD monitoring system for short cable systems to be used in substations that permits to perform synchronized PD measurements using PD sensors placed on the earth connections of the cable terminations and of the tank grounding of the power transformer. The methodology to remove the background noise from the measured signals and to discriminate PD pulses detected is described in the paper. Using the PD amplitude level, the time delay of the arrival instant of the PD pulses and the PD polarity, correct PD diagnosis can be performed. Determination of the emplacement of PD pulses, discrimination of the different PD sources at the same emplacement, identification of the insulation affected by each PD source and the knowledge of the time evolution of each PD source are crucial for a good diagnosis. The paper describes a practical experience in a high voltage substation where specific signal processing tools were decisive to get a correct insulation diagnosis.

2. BASIC CONCEPT OF THE PROCEDURE

The continuous PD monitoring system for three phase short cable systems presented in this paper is composed by two Measuring Systems (MS) installed in each cable end of the short cable system to be monitored. The MS located at the cable ends connected to the power transformer includes four channels: three of them to detect PD signals coming through each cable sheath and the other to detect PD signals coming from the grounding connection of the power transformer. However, the MS located at the cable ends connected to the GIS includes only three PD channels: one for each earth connection of the cable terminations connected to the GIS. All of them operate in the HF range.

HFCT sensors are continuously connected to each MS in order to detect any PD signal coming from far away. When PD pulses come from the same PS source and they are detected by both MS then the PD mapping is automatically started to determine where the PD source is located. When PD pulses are located in a cable end the correct location must be ratified by means of UHF sensors, which output signals can be transformed to HF signals by means of a UHF/HF converter. A pulse polarity method using HFCT sensors is used to ratify where the PD source is located. When different PD sources are placed in the same site, 3D PD clustering tool is also used to distinguish if the pulses source is associated to an internal insulation defect. Pulses sources due to electronic disturbances are identified as characteristic noise