THE USE OF AFTER-INSTALLATION COMMISSIONING TESTS TO ASSURE MV POWER CABLE SYSTEMS MEET MANUFACTURERS' STANDARDS

Stefaan **JESPERS** (1), Massimo **VANOSSI** (2), Marco **GREEN** (3), Benjamin **Lanz** (4)

1 – Cegelec, Brussels, B-1200 (Belgium), stefaan.jespers@cegelec.com

2 – Foster Wheeler Italiana, Corsico, Milan, 20094 (Italy), massimo_vanossi@fwceu.com

3 – IMCORP, Rendsburg, 24768 (Germany), marco.green@imcorp.eu

4 – IMCORP, Manchester, CT 06042 (USA), ben.lanz@imcorptech.com

ABSTRACT

Many common solid dielectric cable system commissioning tests are not comparable with factory tests and provide little or no certainty of future performance. One of the most effective dielectric tests performed in the factory and the field on solid-dielectric cable system components is the off-line 50/60Hz partial discharge (PD) test. Data collected over the last decade supported by test experience on over 40,000 cable system tests will demonstrate the significant improvement in cable system reliability performance that can be achieved using this approach in the field.

KEYWORDS

Medium voltage, Cable Commissioning, Partial Discharge (PD); Off-line, Online, Very Low Frequency (VLF); Withstand

INTRODUCTION

Engineers supporting critical facilities, such as power generation plants, data-centers, and petrochemical facilities, are required to provide a safe and reliable cable system infrastructure that will assure maximum uptime at the lowest cost. In order to assure cable system reliability, an after-installation commissioning test is conducted. Field testing standards and guides have been written to include various types of field tests, but most are not comparable with factory tests, and provide little or no certainty of future system performance. One of the most effective dielectric tests performed in the factory on solid dielectric cable system components is the off-line 50/60Hz partial discharge (PD) test. Ideally this quality control test can be performed in the field. However, specific test parameters must be met in order to assure that the field test results are comparable to manufacturer's acceptance standards. This paper will provide examples of applying factory PD standard thresholds on field test results. The case studies will provide examples of the types of defects which a properly implemented PD test can pinpoint, many of which would be missed by other types of commissioning tests. Field test experience and data collected over the last decade will demonstrate the significant improvement in cable system reliability performance that can be achieved using this approach.

Background: Critical Power Cable Systems

Power distribution for critical processes in modern commercial and industrial installations is commonly achieved by power cable systems insulated with extruded materials such as polyethylene (PE), cross-linked polyethylene (XLPE) or ethylene-propylene rubber (EPR). These vital cable systems are installed underground and in above ground cable trays. Experience obtained while conducting predictive diagnostic evaluations of over 40,000 cable tests indicates that cable system deterioration manifests itself through discrete defects. The vast majority of defects in newly installed solid dielectric systems initiate a deterioration process associated with partial discharge (PD). This failure mechanism causes the insulation to erode over time until a fault channel bridges its entire thickness. Cable defects uncovered during commissioning tests include voids, protrusions, delaminations, and physical damage to the cable screen or metal shield due to excessive sidewall pressure at bends. Some examples of accessory installation defects are poor cable preparation involving nicks, cuts, dimensional and alignment errors, poor void filler application, and contamination. Partial discharge testing and its importance to assuring the reliability of critical power cable systems will be thoroughly discussed in the following sections of this paper.

A Brief History of Cable Testing

During the last century, cable acceptance tests were traditionally carried out by applying a direct current (DC) voltage to a cable at a specific voltage level and for a prescribed duration. The DC high potential withstand test (DC HIPOT), was a reasonable test for paper insulated lead covered (PILC) cables since a significant percentage of defects failed by a process associated with an increase in insulation conductivity. A DC HIPOT was performed in the factory on new PILC cable systems. Thus, repeating the DC HIPOT on PILC in the field was a natural choice. When extruded dielectric cable was introduced in the 1960s, the cable manufacturers were aware that the primary failure mechanism of this type of insulated cable was associated with partial discharge (PD) and not conduction. While the factory PD test (known as a corona test back in the 1960s) was able to detect PD activity in cable and accessories, it involved expensive equipment and required a laboratory with an electromagnetically shielded laboratory. The DC HIPOT is known by manufacturers to be a highly ineffective test with solid dielectric system components and has been removed as a requirement from some of the factory standards for over 10 years. However, the complexities of the PD test all but assured that the field-test industry would continue to use the most widely available and recognized commissioning test (the DC HIPOT). The inability of DC voltage to cause failures in defective extruded insulation during the withstand test led to the introduction of the very low frequency (VLF) or 0.1Hz AC test in the mid 1980s. Unlike DC voltage, VLF voltage was reported to produce sustained PD activity while injecting significantly lower amounts of space charge. However, a major objection to