Permanent PD Monitoring Experience on Shanghai 500kV Power Cable Lines

Yun **JIANG**, Xiaoqing **GAO;** Yunjie **ZHOU;** Shanghai Electric Power Company, China
Chuanqiang **XIAO;** SINDIA Instruments Co., Ltd., China, xiao@sindia.cn

ABSTRACT

For safety operation of a 500kV 15.6km-length power cable line, a permanent partial discharge (PD) monitoring system was installed in September 2013 in Shanghai. Based on the installation and 1-year operational experience of the PD monitoring system, this paper illustrated some key factors for cable line PD monitoring. These factors included high frequency current transformer (HFCT) installation, sensitivity check and alarm set. This paper recommended to use PD pattern recognition method for PD defect evaluation, and to use PD quantitative level only as a reference figure. An operation management system was introduced for power cable condition maintenance. A suspicious signal evaluation case study was presented.

KEYWORDS

500kV Power Cable; PD Monitoring; Big Data, PD Patterns, PD defects;

INTRODUCTION

High voltage power cable line network had become one of the most important power transmission facilities in Shanghai urban power supply networks. Most cable faults occurred in the earlier years of operation, as well as in the ending period of its life cycle. These phenomena followed the bathtub theory. Cable faults in the earlier operation period were caused majorly by assembling defects, and those in the middle aged period were caused mostly by external forces, while those in the ending period of life cycle were caused by aging factors.

PD activities under operation stress were always the beginning of all kinds of cable faults, and were detectable during operation by means of sensitive PD detecting systems. Permanent PD monitoring on HV power cable lines could be one of the ways to identify these defects. Proper handling of these defects was proved to be the most effective way to prevent power interruption caused by cable faults.

Shanghai 500kV power cable line was installed for the power supply of Expo 2010 Shanghai China. It was a double circuit cable line with route length 15.6km.

The rated voltage of the cable line was 290/500kV with cable conductor cross section 2,500mm^2. The cable line was installed under cable tunnel conditions as shown in figure 1.

Figure 1: Site View of Shanghai 500kV Cable Tunnel

Cross bonding sections were used for grounding system of each circuit, ended with GIS terminations in both sides. There were 147 joints and 12 GIS terminations in total of the two circuits. The cable and accessories of one circuit was manufactured in France, and the other circuit was manufactured in Japan. The power line was put into operation in 2010 after 24 hours no load test with U_0.

In June 2013, Shanghai 500kV power cable line had a breakdown in one of these joints, which had caused a blackout in the city centre. A PD monitoring system was installed for on-line monitoring of the cables and all 159 cable accessories. The monitoring system was put into operation in November 2013. The system data had already connected to State Grid monitoring network.

DISTRIBUTED PD MONITORING SYSTEM FOR SHANGHAI POWER CABLE LINE

One cable circuit had 84 cable accessories (78 cable joints and 6 GIS terminations), the other circuit had 75 cable accessories (69 cable joints and 6 GIS terminations). The SINDIA made PD monitoring system was installed with 159 monitoring points. PD signal detectors were installed alongside each accessory and connected by fibre optic loop.

It was a multi levels system consisting of PD signal acquisition in the cable tunnel; signal handling and PD measurement level in the substation; and PD monitoring and alarming level in the central control station.

Signal acquisition level was located in the cable tunnel and the termination rooms. There were 159 partial discharge detectors (PDD) installed with 159 High Frequency Current Transformers (HFCTs) alongside cable accessories as shown in figure 2. All PDDs were connected by fibre optic cable network for data transferring and communicating with the signal data handling level computer. Grounding currents were measured and the phase data of the measured currents instead of voltage were used as the phase reference for PD patterns.

Figure 2: Signal Acquisition Units

Signal handling and PD measurement level was located in one of the cable end substation. There were two PD data handling computers, one for each cable circuit as shown in figure 3. The data handling computers were responsible for controlling & communicating with all the PDDs, which