TOWARDS SMART GRID APPROACH: DATA ACQUISITION FROM ON-LINE MONITORING OF HIGH VOLTAGE XLPE/FLUID-FILLED TRANSITION JOINTS

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ABSTRACT

Diagnostic systems that are able (a) to monitor the condition of an apparatus while (b) providing timely information to grid managers through, e.g., WLAN connections, should be regarded as part of what is called a smart grid, i.e., a grid where bidirectional information flows are used to optimize the working point of the system. To demonstrate this proposition, this paper shows the characteristics of a partial discharge monitoring system that was used to meet load growth projections with minimal expenditures. Advanced signal processing techniques coupled with Internet connectivity and database management tools make the system capable of providing critical information about link reliability, enabling it to become part of the grid management system.

KEYWORDS

Smart grid, Asset management, Monitoring, Partial discharges,

INTRODUCTION

The smart grid paradigm is leading the electrical industry to conceive in new ways network operation. Greater emphasis is put on the pervasive use of new sensors/systems/techniques to improve power flows in grids that must accommodate distributed generation while dealing with limited expenditure capability.

These conflicting requirements emphasize that the grids of the future will be operated with tight limits, stretching the applicability of well-assessed practices. For instance, it should be borne in mind that the failure rates used to assess transmission reliability are only average values over a class of components and do not represent the actual failure risk of a specific component. Thus, conventional reliability analysis based on failure rates derived from databases may not be sufficient to get the optimum grid configuration in terms of both transmission capacity and reliability. As a consequence, the demand for systems that are able to predict in an accurate way the failure risk for critical components is increasing.

To show these concepts, reference will be made to a new substation erected in a densely-populated metropolitan area to improve reliability and meet load growth. The substation reliability depends heavily on fluid filled / XLPE transition joints, as shown in the next Section. Therefore, the utility decided to equip these joints with an innovative partial discharge monitoring system, whose characteristics fit the smart grid paradigm.

This paper will provide details of the monitoring scheme, focusing, on those features that enable the system to provide meaningful information for network operators to manage, e.g., maintenance, load flow and possible congestions. Overall, the content of this paper will show how innovative devices can be used to accommodate basic grid management issues (e.g., meeting load growth projections) with minimal capital expenditures.

BACKGROUND INFORMATION

The Long Island City area in Queens, (NY, USA) was supplied until 2008 from one substation (in the north) with a total installed power of 483 MW, a power that, according to forecasts, would be exceeded in 2014. ConEdison decided to meet load requirements by adding a new substation in the south. To avoid long feeder routes and extensive construction activities, it was decided to feed the five transformers of the new substation by tapping two new lines from an existing 138 kV High-Pressure Fluid Filled (HPFF) cable line. While it was decided to use XLPE-insulated cables to connect the transformers, the very first 275 meters of the new lines were realized using paper insulated cables to maximize the reliability of the Y-type joints used to tap the 138 kV feeders. Paper-to-XLPE Transition Joints were then employed. This solution minimizes grid expansion costs, but depends heavily on the reliability of the transition joints. These are the most critical elements of this uprating scheme, since their reliability heavily depends on the quality of the assembly on field.

To maintain adequate reliability levels, it was decided to monitor the possible inception and evolution of partial discharge activity in the weakest elements of the link, i.e., the transition joints and the XLPE cables. The selected monitoring system is endowed with advanced tools that allow (a) to have a bidirectional communication between monitoring systems and SCADA centers, (b) to monitor separately phenomena having waveforms with different characteristics, (c) to set up intelligent warning systems for each type of detected source. Since monitoring systems are well known to produce vast amounts of data, feature (c) is particularly interesting since warnings signals (generally based on PD magnitudes and repetition rates) can be upgraded or downgraded depending on the type of source, allowing a more rational use of human resources.

In the following hardware, software and signal treatment strategy of the PD monitoring system will be described.

PARTIAL DISCHARGE MONITORING SYSTEM FEATURES

System architecture

The PD monitoring system consists of two acquisition boxes, each installed in one transition joint manhole (for two circuits), and one Central Unit (CU) installed in the substation Control Room.