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Using Data from SCADA for Centralized Transformer Monitoring Applications

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Abstract

Modern Supervisory Control and Data Acquisition (SCADA) systems collect any available data from the systems they monitor and control. Some of the data available in modern SCADA systems include types of the data that can be used for centralized monitoring of transformers. Paper presents possible advanced analysis and reports for monitored transformer units using available SCADA data to be used for monitoring of the life of the transformer and help to schedule regular, predictive and corrective types of maintenance. Paper shows which type of data is available, and what percentage of transformers has the kind of data used for monitoring. Examples of measurement data collected are shown for representative transformers. There is an overview on tap changer position moves and its impact on transformer lifetime and servicing interval. For transformers with available temperature of winding an annualized relative ageing rate is calculated.

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1. Introduction

Advancement in telecommunications and computing in modern Supervisory Control and Data Acquisition (SCADA) systems allow for collection of any available data from the systems they monitor and control [1]. This diverse data are, beside the main monitoring and control functions, used in smart grid transmission control centers by many advanced tools and applications [1] [2]. Some of the data available in modern SCADA systems include

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types of the data that can be used for centralized monitoring of transformers. Transformer unit in transmission network is a crucial and expensive element, often unique and hard to replace. All of those are the reasons that careful attention must be provided for transformer during its lifetime.

Monitoring systems for large power transformers are widely used at transmission system operators and at power plants [3] [4] [5] [6] [7] [8] [9] [10]. These systems are mostly tailored made for specific power transformer and have complex specifications and design [11] [12]. Monitoring system tracks power transformer status using three major monitoring types: current monitoring [13], overvoltage monitoring and gas analyses. Last two monitoring types have to have additional equipment placed on a transformer tank. This equipment is necessary to trace complex events caused by overvoltage (atmosphere or switching) and oil – gas relations.

Task of monitoring power transformers based on current measurements can be shifted to a SCADA system in control center because current or power and voltage measurements from most of power transformers come to SCADA. Using SCADA most of the transformers at transmission system level and at power plants can be monitored, which can be very valuable for asset management. Current monitoring can be extended with other data from SCADA database, like oil and winding temperature [14], number of operating hours (days) in a year, number of tap changer operations, and some other signals.

SCADA database contribute to transformer monitoring in a specific way. Data are available continuously and a report can be easily and automatically generated for a period of a week, a month or a year, for several years in the past. Data collected by SCADA contains valuable information for planning and maintenance procedures of power transformers, especially when customer or owner does not have a classic monitoring system. That information can be used in the further step of condition based maintenance (CBM) in a company. It is in TSO's interest to have such analysis in order to predict maintenance schedule and have good insight in the actual state of all power transformer unit.

2. Data Available in SCADA System of Power Transmission System Control Center

2.1. Network Model in SCADA System

Signals and measurements that come into SCADA system in power transmission system control centers are attached to the energy management system (EMS) network model. This network model represents stations, lines, generators, transformers, buses, and other elements needed for various EMS calculations. The EMS network model contains topology information connecting signals and measurements to elements in the network model. The EMS network model contains also various parameters on elements describing types of transformers, rated power and voltage, location and type of tap regulation, and other useful information. Parameters and placement of transformers are used for putting signals in measurement in context (e.g. getting maximum value for current from rated power and voltage) and for classification of types of transformers. Transformers can be classified using different criteria: ownership, voltage levels, rated power, type of winding, function, etc.

The EMS network model must also contain neighboring elements which are not owned nor maintained by the transmission company even though they are supervised. This paper will show a possibility for centralized monitoring for both owned assets and just supervised transformers.

In the whole EMS network model there are 543 transformers, of which 350 are power transformers owned by transmission system operator (TSO) or distribution system operator (DSO), 76 are supervised auxiliary transformers (other transformers not used for transmission or distribution), 100 transformers are in external network, and 17 are owned by a generation company and only supervised, which can be seen in the Table 1.

Table 1 Number of transformers in the EMS network model

	110/x kV	220 kV and 400 kV	Total
(TSO+DSO) operating assets	308	42	350
External	29	71	100

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