SC C4 System technical performance
PT 3 Computational advances in tools, models, methodology and analysis of power system technical performance related issues

Corona losses reduction of OHL 500 kV of Omsk electric power system based on signal processing of PMU

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Despite the concrete success in studying of ultra-high voltage transmission line corona effect, the problem of realistic measurement and reduction of corona losses under optimization problem solution of electrical energy system modes control is as relevant as ever.

Under the conditions of implementation of Smart Grid conception, which is presume to integrate into substation and electrical power plants equipment of modern intelligent devices and monitoring and control systems, methods based on signal processing of PMU can be considered as promising. In this case, highly-accurate synchronised measurements of regime parameters of two sides of OHL followed by identification of parameters of OHL equivalent circuit and/or dividing transmission line total losses into load losses and corona losses, is render possible to solve a voltage and reactive power mode optimisation problem to the full extent. In addition, one of major aspects is a measurement error compensation problem.

In the furtherance of this goal in the paper, the problem of method and algorithms development operational monitoring of corona losses and regime optimization based on signal processing of synchronized vector measurements of operating OHL 500 kV of Omsk electrical energy system is solving.

The initial data is positive-sequence voltage and current vectors of basic frequency, which is measured synchronously with given periodicity. For remedy of ambiguity of obtained solution, it's supposing that error of measurement voltages and currents exists in the sending end of the transmission line and measurements of the receiving end are taken for standard samples. Due to lower variation of voltages in comparison with currents of line ends and high accuracy of time-synchronized data, the voltage angle systematic measurement error is neglected. Because of voltage magnitudes greater influence on shunt admittance identification error and mutual influence between measuring current and voltage transformer magnitude errors the measuring current transformer magnitude error is neglected. Systematic error parameters are taken as constant values for an identification time interval (up to 10 minutes). Random measurement errors of voltage and current have near-normal

distribution law. Fluctuations of transmission line regimes parameters (voltages and currents) exceed by degree random errors of measurement systems.

Measured from PMU arrays of operational current and voltage vectors for each 20 ms with time marks are passing to data concentrator, where they are stored with predetermined archive depth. The noted data is being reading and written to a template during this time.

The algorithm of U-shaped OHL 500 kV equivalent circuit parameters identification is represented in Matlab. PMU data is passed in proper format and then transferred to Matlab for each phase separately. Currents, voltages and angles for ends of transmission line are reduced to the one unit of measurement accordingly. Then the program form variables as complex values of currents and voltages for end of transmission line. The data is verified, averaged and then U-shaped OHL equivalent circuit parameters are calculated. After identification of U-shaped OHL equivalent circuit parameters for each 20 ms time segment, corona losses are determined for the considered time interval.

Calculated corona losses are passed to optimization module, where control signals for automatic voltage regulators of synchronous generators and controlled shunt reactors are formed, thus complete a closed loop.

The high efficiency of the proposed approach is proved, based on numerical and field studies, design work of development of specialized software and hardware suite is completed. The software and hardware suite consist of three main modules: measurement of corona losses, mode optimization and signal conditioning of automatic control.