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Power system operation efficiency increasing considering transfer capacity parameters affection

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The United power system of Russia (UPS of Russia) is one of the largest power systems in the world, characterized by the special network (both transmission and distribution) structure. The aim of large amounts of power transmitting over such long distances is very important because powerful power plants and large power consumption nodes located at a considerable distance from one another and across several time zones. The main network (with a nominal voltage of 330 kV and above), is not sufficiently developed, because of large length, and is shunted by the 110 - 220 kV network with limited transfer capacity. The allowable currents of distribution network 110-220 kV is limited by substation equipment parameters and wires of transmission lines load capacity, which are directly dependent on the outside temperature.

The permissible area UPS of Russia operation is determined by the maximum allowable active power flows in controlled cross sections (MAF). The values of MAF must satisfy six criteria according to the **"Methodological guidelines on the power systems stability"**, approved by order of the Ministry of Energy of the Russian Federation (30.06.2003 № 277). One of the criteria for the MAF determination is allowable current load of transmission lines and electric grid equipment in post-emergency conditions after rated disturbances. In most cases, this criteria limits MAF, and therefore the range of permissible operational modes of the UPS of Russia. Often, the distribution electrical network is operated in so-called “open condition” (radially), and this is the reason for a decrease in the reliability of the consumers power supply.

The transfer capacity (allowable currents) of both high voltage and distribution transmission lines depends on the outside temperature. MAF calculations for the worst weather conditions (without considering real or predicted temperature) leads to reducing of the range of admissible operational modes in our power systems. Consequently, this reduction lead to possibility of exchanging power between the individual energy centers, energy districts and energy systems within the UPS reduction.

According to abovementioned, if we take these temperature factors into account during MAF calculation, it allows us to use all transfer capacity of any type of networks. A similar approach may be used when making technical solutions for emergency control systems, which can significantly improve effectiveness of emergency operation of power systems. Thus, the setting of automation, which limits equipment overload, should take into account

the temperature factor for excluding an excessive control actions realization (or reduces the amount of required control actions), including load shedding.

This report describes the methodology of the temperature factor using when determining the values of MAF based on the principles of MAF calculations, according to the Standard of Organization of the JSC “SO UPS", **"The rules for determining the maximum allowable and emergency allowable power flows in controlled cross sections in the dispatch centers of JSC "SO UPS"**, as well as determining a logic operation, adjustment and the amount of control actions from emergency control systems.

The report also reviews the various features of the practical application of this methodology in terms of setting up emergency control devices. The implementation of this methodology is also relevant for solving the problems of planning and power system operation.

At present, experts of the System Operator have completed MAF calculations for the entire spectrum of outdoor temperatures for all controlled cross sections in the UPS of Russia. It makes possible to significantly expand the range of allowable power system operational area and to decrease the relevance of the problem of active power flows limitation in heavily loaded controlled sections.

Technical solutions to integrate the outdoor air temperature in the implementation of emergency control have been developed and implemented in emergency control systems, allowing us to increase the transfer capacity of the electric network and to reduce (optimize) required control actions.

The report will focus on practical results of the application of the abovementioned methodology and goals setting for further development and improvement.