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Automatic device of monitoring of stability margins

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Control of the current operating conditions is a necessity for secure managing of any technical object. Typically, this control is carried out by means of technical instruments of monitoring of a certain set of parameters that provides essential understanding of the current state of the controlled object.

One of the main features of a power system, as a management object, is the necessity to evaluate the current state with regard to possible accidental disturbances. For operating personnel it is almost impossible to solve the problem of comparing the operating parameters in terms of current conditions and possible post-emergency conditions. It looks even more impossible, with regard to the variety of potential emergencies in each scheme and state of a power system.

To overcome this difficulty, the control of a current state is performed by comparing the values of a certain number of key parameters with the pre-defined set of their margin values. The latter are defined as constraints in the normal state (the maximum allowable current, minimum and maximum values of voltage and frequency) and constraints arising in emergency situations.

In each of the regional interconnected power systems (IPS), parts of UPS of Russia, a number of sections of electrical network can be defined, the power flow through which can, under certain conditions, exceed stability margins or current-carrying capacity of the network elements. The System Operator must constantly monitor these sections to ensure the reliable operation of a power system.

During the period of 2013-2014 the automatic device of monitoring of stability margins was developed and currently the stage of industrial testing in the IPS of Urals and IPS of North-West is ongoing.

Software package of the device computes the present stability margins on basis of measurements of operational parameters and develops recommendation for adjustments of the power flow through the controlled section of electrical network. Software package algorithm allows the following:

− state estimation in the current and possible emergency operating conditions;
− evaluation of static stability margins;
− determining the worst schemes on conditions of static stability, the assessment of the stability margins in the initial operating conditions, controlled sections and most severe emergency;

− assessment of transient stability margins, taking into account the emergency control actions, if any;
− determining the network overcurrent in the post-emergency conditions;
− determining the necessity to change the power flow through the controlled section to prevent the violation of transient stability;
− elaboration of recommendations on the most efficient ways to change the power flow through the control section to ensure the reliable operation.

For measurement and transmission of the current values of operating conditions parameters the modern technical means, including the device type WAMS, are used.

The mathematical method, which is used in the automatic device of monitoring of stability margins, is based on Russian classical methods of calculation of operating conditions and determination of static and transient stability margins. In addition, for the main parts of the algorithm such as: choice of vector of changing of operating conditions, computation of transient stability, determining the minimum of required control actions of emergency automation, choosing of a particular means of emergency management for specific emergency and for the solution of a number of other tasks the unconventional methods were used. These methods were previously tested during implementation in UPS of Russia of centralized emergency automation system.