

**SC C2 – System Operation and Control**  
**PS1 «Capabilities required for future system operation»****Stability margin monitoring systems – tool to increase grid capacity****V.A. DYACHKOV, E.I. SATSUK, I.S. OKSHIN****JSC SO UPS****Russia**

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To provide reliable operation of the United Power System of Russia (UPS of Russia) is one of the most important tasks in system operation. To ensure permissible values for electrical mode parameters both under normal and post emergency conditions resulting from the normative disturbances JSC System Operator of the United Power System of Russia (JSC SO UPS) defines the values of the maximum permissible active power flows (capacity) in the controlled sections (MPPF).

MPPF is determined to secure stability of power system operation, safety and reliability of the generating facilities and demand units in accordance with the requirements set out in “Methodical instructions on stability of power systems” 03 August 2018 (MI) and to provide:

- reference static aperiodic stability margin factor for active power in the controlled section in normal mode;
  - reference static aperiodic stability margin factor for active power in the controlled section in post-emergency mode after reference incident;
  - reference static stability margin factor for voltage at the load node in the post-emergency mode after reference incident;
  - power plants generating units dynamic stability after reference incident;
- permissible current load for transmission lines and grid equipment in post-emergency mode after reference incident;
- reference static stability margin factor for voltage at the load node in the normal mode;
  - permissible transmission lines and grid equipment current load in the normal mode;
  - Absence of deficit power system shutdown (load area, power node) due to controlled islanding at the result of reference incident

To ensure permissible modes for the UPS of Russia operation under all typical scheduled and balancing conditions the MPPF values should be determined for the most hard scenario conditions, without considering power system actual operational modes. Herewith, UPS of Russia current operational modes can differ significantly from the calculated values (regarding power plants loading, power systems demand, levels of voltages and other electrical modes parameters) so physical MPPF can exceed values, determined for the most hard operation conditions.

To consider scheduled and balancing operational conditions at calculating MPPF, JSC SO UPS together with the experts of the JSC “Scientific Technical Center of the UPS of Russia” (JSC STC UPS) have set up a Stability Margin Monitoring System (SMMS). SMMS performs cyclical calculations of the active power permissible flows factual values in the set controlled and found dangerous sections automatically, considering actual parameters of electrical mode.

The actual telemetric data from the operational information complex is used as the input data for the calculations. After the state estimation of the electrical mode and design of the calculation model, SMMS automatically determines the actual values of the maximum permissible active power flows in full accordance with the requirements of the MI. In this case, when calculating the maximum permissible active power flows, the permissible current loads of grid elements, permissible voltage levels and settings of devices [complexes] of emergency automatics are taken into account.

After calculation of the active power permissible flows actual values in the controlled sections, the obtained MPPF values are checked according to a number of formalized criteria to exclude the use of incorrect information in mode control.

In addition to the power system electrical mode operational control circuit, SMMS is used for electrical mode planning. This makes it possible to determine the optimal switched on generating units list and generating units operational mode.

The results of SMMS calculations are used as setting for automatic limiters of active power flow in the controlled sections, to eliminate excessive power plants active power change to input mode into the permissible area.

Currently SMMS is put into operation in four dispatch centers where successfully ensure increase of the permissible modes range in the UPS of Russia.

The article describes the main tasks and functions, methods of implementation and prospects of development of the SMMS. Particular attention is paid to the experience of using SMMS both for operational control and power system modes planning.