

SC B5 Protection and Automation
PS 1 Protection under system emergency conditions

Methods for determination of parameters variation of the electrical mode of the power system and their use for the power system control objectives

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Analysis of current parameters of electric power mode of the power system is basis for the management solutions making by operating and dispatching personnel and an information platform for operation of the relay protection, mode and emergency control (MEC) to ensure quality and reliability of electric mode control of UES of Russia.

Oscillation of the electric mode parameters (EMP) is a characteristic feature of the power system determined by technology of parallel operation of the synchronous generators as part of the power system. Assurance of oscillating stability of the power system under normal and emergency modes of its operation is one of the objectives solved by SO UPS JSC specialists, so large attention is applied to development of the methods for identification and analysis under real time mode EMP oscillations occurred in the power system. Actually the objective solution means identification of EMP oscillations dangerous for the power system equipment parameters, features efficiency estimation of equipment regulation systems for damping and prevention of the synchronous oscillations escalation to asynchronous conditions emergency for the power system, timely determination of set of prompt measures preventing loss of stability of the equipment operation.

Currently large attention is paid to the methods of EMP low-frequency oscillation danger identification and analysis for the power system. EMP low-frequency oscillations monitoring using technology of synchrophasor technology (SPT) is one of the priority tasks of SO UPS JSC. In Russia there is large volume of actual materials relating identification and analysis of system (local and inter-area) and forced LF oscillations occurred in UPS of Russia. To study LF oscillations monitoring circuit and mode operation conditions of the power system is used with estimation of their effect on parameters of modes and level of oscillations damping, computer simulation of the transients in the power system, and analysis of the technological violations linked with occurrence in the power system of the emergency power unbalance, short circuit, disconnection of lines and electrical equipment.

Specialists of SO UPS JSC suggested and tested the following methods of identification of LF oscillations and their sources:

- method of correlation analysis of damping factor of dominant mode and active power of the synchronous generators of the power system;
- method of analysis of EMP spectrograms;
- method of selection of damping factor of dominant mode of EMP LF oscillations;
- method of identification of synchronous generator with mode leading phase;

- method of identification of peak amplitude of LF oscillations relatively to phase angle of voltage;
- method of statistical analysis of operation mode of industrial power objects.

Said methods will be also used in real time.

Major part of time EMP LF oscillations are not dangerous for mode reliability and safety of the power system, but upon large amplitudes achievement can result in serious technological violations and damage of the generating equipment. The spectrum analysis executed by specialist of SO UPS JSC according to SFT shows that in UPS of Russia additionally to the system oscillations the rather intensive forced LF oscillations are observed. Identification of sources of the forced LF oscillations with taking technological measures eliminating their negative effect on the oscillatory stability of the power system is one of the priority tasks.

The paper reviews the dampening methods of LF oscillations. The most effective method of EMP LF oscillations suppression includes automatic voltage regulators (AVR) of synchronous generators. The authors investigated effect of setting of AVR regulation channels and system stabilizers as part of AVR for dampening LF oscillations of various nature of occurrence, various frequency, and various amplitude. It was shown that AVR proper setting in the power system significantly reduces risk of the oscillatory stability violation and asynchronous conditions occurrence.

But danger of LF oscillations transfer to asynchronous conditions, as well as danger of the asynchronous conditions occurrence is kept. So, one of the important tasks of the emergency control is the asynchronous conditions liquidation. The paper specifies the requirements for organization of automatic asynchronous conditions liquidation system in UVS of Russia, methods of place identification of electric center of oscillations under the asynchronous conditions, examples of operation algorithms of devices of automatic asynchronous conditions liquidation (AACL) installed on the synchronous generators and power transmission lines.

The paper also contains examples of use of EMP oscillations monitoring results for tasks of operational and dispatching control, setting of mode and emergency automatic devices.