

Requirements for relay protection and automation applications of electric power stations, providing stability of their operation in electric power system

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Providing stable operation of electric power generation equipment in power system is an important task of automatic control systems: relay protection, remedial action protection schemes, power system regime and technological automation applications. Solving this task is possible only when operation of all aforementioned systems is coordinated.

This paper describes technical solutions, which allow for increasing electric power generation equipment operation stability at fault conditions in power system. These solutions have been developed with the aim to:

- increase relay protection operation speed in electric power stations;
- optimize architecture of relay protection systems and coordination of specific automation functions, providing stability of electric power generation equipment and robustness of electric power system in general;
- satisfy automation functions configuration requirements to provide their coordination with relay protection of electric power system and adopt their operation to local requirements.

One of the main faults to be considered in electric power systems are short-circuits. Relay protection task is to identify faults and to disconnect faulted equipment from the network with minimum latency. To satisfy this requirement electric power stations and other facilities include high-speed protection relays. Due to the specifics in switchgear layouts, so called “dead zones” exist in electric power stations. Faults in such zones may be cleared only by breaker-failure protection, which operation time normally exceeds permissible fault clearance time, stipulated by the dynamic stability requirement. This paper describes algorithm and technical solutions, which allow for implementation of selective fault clearance in “dead zones” of electric power station switchgear and provide an increase in electric power generation equipment stability.

In those cases when relay protection is not capable to guarantee electric power generation equipment operation stability, remedial action protection schemes, given severity of the fault and relay protection operation characteristics, have to generate control signals to preserve parallel operation of all (or a part of) generation equipment with the network. At different stages of fault condition, coordinated operation of the following remedial action protection schemes has to be provided:

- generators operation stability failure prevention function - at close in and delayed faults - providing short-time or protracted load shedding of generators and their disconnection from the network;

- synchronous generators excitation control function, providing excitation boost and damping of synchronous power swings in post-fault mode to prevent power swings amplitude and duration at transients;
- asynchronous operation mode elimination function, providing disconnection of generator in case its stability failure for the purpose of asynchronous mode propagation throughout the system;
- frequency increase limitation function, saving part of generators at active power surplus;
- frequency dividing automation function, providing possibility to save generating equipment in operation (islanding, auxiliary needs) at frequency decrease conditions.

Requirements of Russian standards differ from the requirements of foreign standards in respect to permissible operation modes of generating equipment, set of protection devices, installed in electric power stations. These differences are stipulated by the difference in operating conditions of generation equipment. Therefore additional requirements are placed on generating equipment and protection devices of foreign makes.

This paper includes examples of foreign equipment, protection algorithms and their configuration adoption to Russian standards' requirements, for example:

- change in permissible operation duration of gas turbines at different frequency ranges;
- modification of turbines technological automation function algorithms, providing their stable operation at standard disturbances;
- generators excitation control algorithms modification to meet the requirements of Russian standards in respect to excitation boost and system stabilization;
- modification of mobile gas turbine power plants governing algorithms to provide their participation in frequency regulation procedure.

Requirements, presented in the paper, are aimed at increasing the operation stability of generating equipment of electric power stations and power system itself through the development of technical solutions to increase technical perfection of relay protection and its coordinated operation at all stages of fault modes in electric power system.