Mitigation of Cascading Power Outage Caused Power Swing Disturbance Using Real-time DLR Applications

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Abstract : The power system is one of the most important systems in modern society. The existing power system is approaching the critical operating limits as views of several power system operators. With the increase of load demand, high capacity and long transmission networks are widely used to meet the requirement. With the integration of renewable energies such as wind and solar, the uncertainty, intermittence bring bigger challenges to the operation of power systems. These dynamic uncertainties in the power system lead to power disturbances. The disturbances in a heavily stressed power system cause distance relays to mal-operation or false alarms during post fault power oscillations. This unintended operation of these relays may propagate and trigger cascaded trappings leading to total power system blackout. This is due to relays inability to take an appropriate tripping decision based on ensuing power swing. According to the N-1 criterion, electric power systems are generally designed to withstand a single failure without causing the violation of any operating limit. As a result, some overloaded components such as overhead transmission lines can still work for several hours under overload conditions. However, when a large power swing happens in the power system, the settings of the distance relay of zone 3 may trip the transmission line with a short time delay, and they will be acting so quickly that the system operator has no time to respond and stop the cascading. Misfiring of relays in absence of fault due to power swing may have a significant loss in economic performance, thus a loss in revenue for power companies. This research paper proposes a method to distinguish stable power swing from unstable using dynamic line rating (DLR) in response to power swing or disturbances. As opposed to static line rating (SLR), dynamic line rating support effective mitigation actions against propagating cascading outages in a power grid. Effective utilization of existing transmission lines capacity using machine learning DLR predictions will improve the operating point of distance relay protection, thus reducing unintended power outages due to power swing.

Keywords : blackout, cascading outages, dynamic line rating, power swing, overhead transmission lines

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