System-Wide Case Study Assessment of Transformer Heating Due to Geomagnetic Disturbances

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Abstract

When a solar geomagnetic storm occurs, a burst of plasma carrying intense magnetic fields is released into the magnetosphere. A sudden change in the earth's magnetic field, in turn, induces currents in long conductors such as power transmission lines on the earth's surface. The geomagnetically induced currents (GICs) are a potentially catastrophic threat to large-scale power system operations especially the bulk transformers, possibly leading to severe outages. This paper provides a system-wide transformer temperature analysis due to GIC-induced half-cycle saturation. The derived thermal assessment model identifies the potential overheated transformers in a geomagnetic disturbance (GMD) event and characterizes the relationship between the GIC (frequency of occurrence and magnitude) and the corresponding temperature rise at each transformer. The suggested approach is applied to the 20-bus GIC benchmark test case as well as a large-scale 2000-bus synthetic test system facing a GMD event, where the time-varying temperature responses are evaluated and numerically analyzed in both normal and contingency scenarios.

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