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Effectiveness of Superconducting Fault Current Limiting Transformers in Power Systems

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Superconducting devices have emerged in many applications during the last few decades. They offer many advantages including high efficiency, compact size, and superior performance. However, the main drawback of these devices is the high cost. An option to reduce the high cost and improve the cost-benefit ratio is to integrate two functions into one device. This paper presents the superconducting fault current limiting transformer (SCFCLT) as a superior alternative to normal power transformers. The transformer has superconducting windings in both primary and secondary sides and also provides fault current limiting capability to reduce high fault currents. The performance of the SCFCLT was investigated considering the thermal behaviour of the superconducting windings. It works as a low impedance transformer in normal conditions and as a resistive-type fault current limiter during fault periods. A detailed model of the SCFCLT was developed based on the different states of superconducting tapes according to the critical current and temperature rise of the tapes. These values were determined based on the transformer current ratings and the number of turns on each side. The SCFCLT is tested in two power system models: a 7 bus wind farm based model simulated in PSCAD and on the 80 bus simplified Australian power system model simulated in RTDS. Various conditions were studied to investigate the effectiveness of the fault current limiting transformer. Results illustrated the ability of the SCFCLT to limit high fault currents from the first cycle effectively. Also, the several scenarios proved that adding SCFCLT at strategic locations in a power system improves stability.

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