A study of lightning protection for wind turbines

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Abstract

Effective protection for wind turbines from lightning strokes has recently been in strong demand, because wind turbines are frequently exposed to lightning strokes due to their tall structures. Damage to wind turbines due to lightning is much greater than originally anticipated, and the influence of lightning faults on safe and reliable operation of wind turbines is an increasing concern.

We have been operating a wind farm, TAPPI Wind Park, since 1992. TAPPI Wind Park has eleven wind turbines and total capacity is 3,375kW. Lightning faults have been experienced more than ten times at TAPPI Wind Park so far. Repair costs, mainly for damaged electric devices, and loss of power production, have reached an unacceptable level and made us seriously investigate successful lightning protection methods for wind turbines.

The impulse current test was applied to reduced wind turbine models and a real wind turbine at TAPPI Wind Park in order to determine the lightning current path and the voltage induced in shielded control cables. Experimental results of the test are shown and effective lightning protection methods for wind turbines are discussed in this paper. Followings are main issues of this work.

The results of the impulse current test show that almost all the impulse current applied from a blade flows from the main shaft bearing to the tower. When the impulse current flows through the moving elements of the wind turbine such as bearings, significant mechanical damage or shortened life might occur on the relevant moving elements. It is considered that an alternative current path for the impulse current should be installed across the moving elements.

In addition, it was confirmed that the voltage induced in shielded control cables is much lower when the shield is earthed at both ends of the cable compared with one-side earthing. Therefore, both ends earthing of the shielded cables can contribute toward avoiding damage to control panels and electric devices connected to both ends of the cables.

We also found a difference in voltage induced in the shielded control cables when the lightning rod is grounded through a tower, vinyl-insulated wire and high-voltage insulated cable. The high-voltage insulated cable has the lowest induced voltage, and the voltage drop generated in it is also the lowest because it has the lowest impedance. In order to minimize damage to electric devices in the wind turbine, the high-voltage insulated cable should be used to earth the lightning rod.