

Study on Lightning Damage Mechanism of Wind Power Generators

Background

In recent years, the utilization of wind power is rapidly increasing in electric power supply. The increasing number and height of installed turbines have resulted in an increase of lightning damages. Especially lightning damage to wind turbine blades is quite serious since the cost of replacements is remarkably high and a long repair time is necessary. Hence, lightning protection measures for wind turbines are becoming increasingly important as their use is rapidly increasing.

Objectives

In order to prevent lightning damages of wind power generators, lightning attachment characteristics to wind turbine blades will be studied experimentally using a large high voltage generator at Shiobara Testing Yard. Moreover lightning surge phenomena in the electrical circuits and the control circuits of wind turbine generators will be analyzed.

Principal Results

1. Lightning attachment characteristics to wind power generators

Using a large high voltage generator at Shiobara Testing Yard, lightning attachment characteristics to wind turbine blades were clarified experimentally.

- (1) Lightning can discharge to blades made of insulated material only. In the case that the insulation strength of material was not enough, discharge stroke penetrated the material and intruded inside.
- (2) Insulation strength of blade materials decreases if the surface of them is polluted by the adhesion of a salt deposit. At seaside or offshore locations, the effect of pollution should be taken into consideration for non-conductive blades.

2. Experimental study of lightning overvoltages in wind power generation systems using a reduced size wind turbine model

The voltage rise due to the tower footing resistance can cause a significant voltage difference between the tower foot and an incoming conductor led from a distant point. Also, a voltage difference between the bottom of down conductors installed inside the tower and an incoming conductor can be of significance.

3. Relation between lightning hazard map and lightning damages of wind power generator

Taking into account not only flash density but also peak value of lightning currents, a lightning hazard map has been made. Lightning damage frequently occurs in areas where the lightning risk is large.

Future Developments

Further investigation is necessary to conduct detailed analysis of the destruction mechanism when the discharge propagates inside blade. In addition, appropriate lightning protection methods for wind turbine blade such as the shape and mounting position of receptor should be studied. Moreover, analysis of electric field distribution around a wind turbine under a lightning cloud also deserves investigation in order to understand the attachment manner of lightning stroke to wind turbines.

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Reference

A. Wada et.al., 2004, An Experimental Study on Discharge Characteristics of Non-metallic Materials - Fundamental Discharge Characteristics of Model Wind Turbine Blades - , CRIEPI Report T03026 (in Japanese)

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Fig.1 Damage of wind turbine blade due to lightning



Fig.2 Lightning discharge on wind turbine blade model

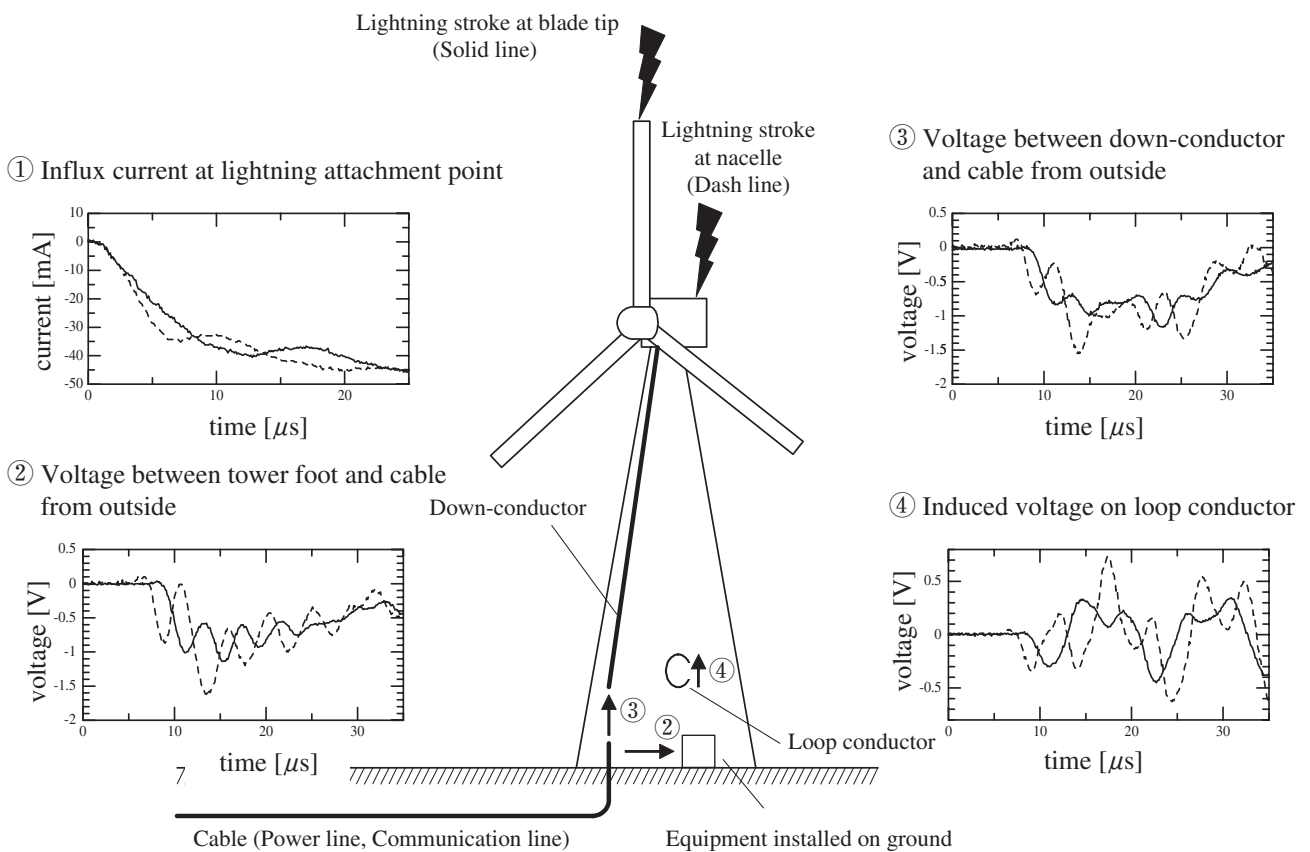


Fig.3 Generated overvoltage between down-conductor and lead-in cable