

Background

In recent years . . .



Increasing the installation number of Large-sized wind power system,



The height to a blade tip exceeds 100m



Damage by lightning strike is increasing . . .



In most cases the control system is damaged.



Systematic lightning protection was installed urgently built.

Then,

Lightning protection of the control system was tested.

The purpose of this protection was to improve the operation rate of wind power system.



Abstract

The purpose is to grasp the level of the over voltage generated between the core of control cable and the nacelle or tower structure which is one of the causes of damage to the equipment installed in the tower.

An impulse current test was performed and the over voltage (the common-mode voltage) was measured which occurs between the wind turbine body and the equipment.

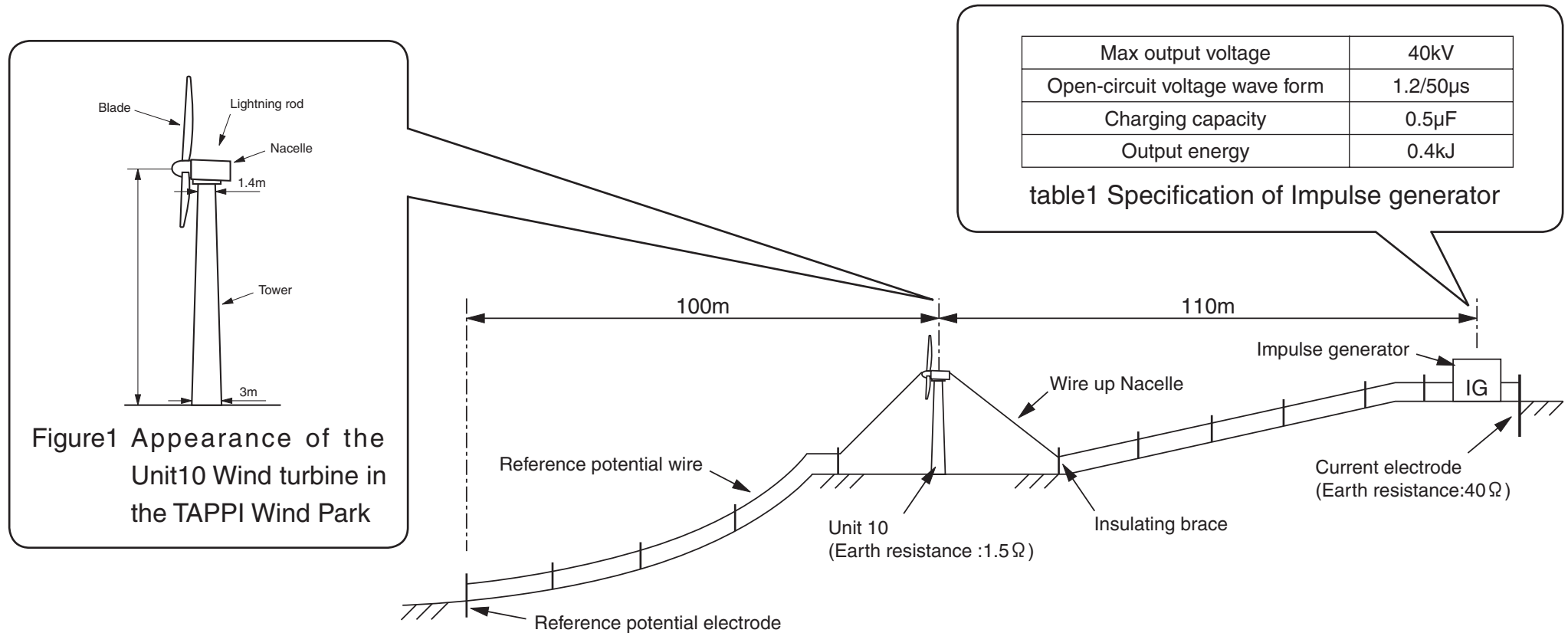
The results of this test and measurements;

- ① The over voltage between tower body and the core of control cable becomes the lowest voltage in case of shielded-cable with earth at both ends.
- ② In case of the equipment installed at the lower part of the tower, not so much over voltage difference between shielded cables with earth at both ends and with earth at single end, is observed.
- ③ The voltage on the side of the nacelle becomes the higher voltage.
- ④ In case of the unshielded-cable, the over voltage is higher than the shielded-cable.
- ⑤ It is confirmed that the electric potential of the nacelle becomes extremely higher than the earth potential.

Impulse current testing circuit

Measurement of over voltage generated in equipments inside Wind Turbine.

Schematic view of impulse current test.



Composition of measurement

Measurement of over voltage generated in equipments inside Wind Turbine.

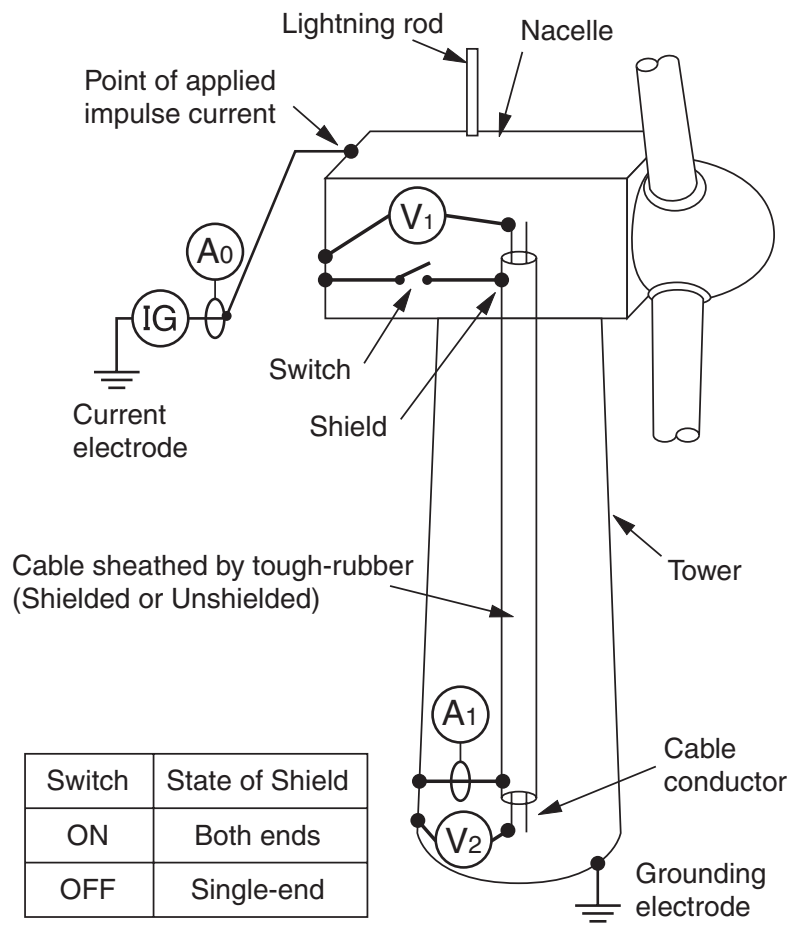


Figure3 Measurement points

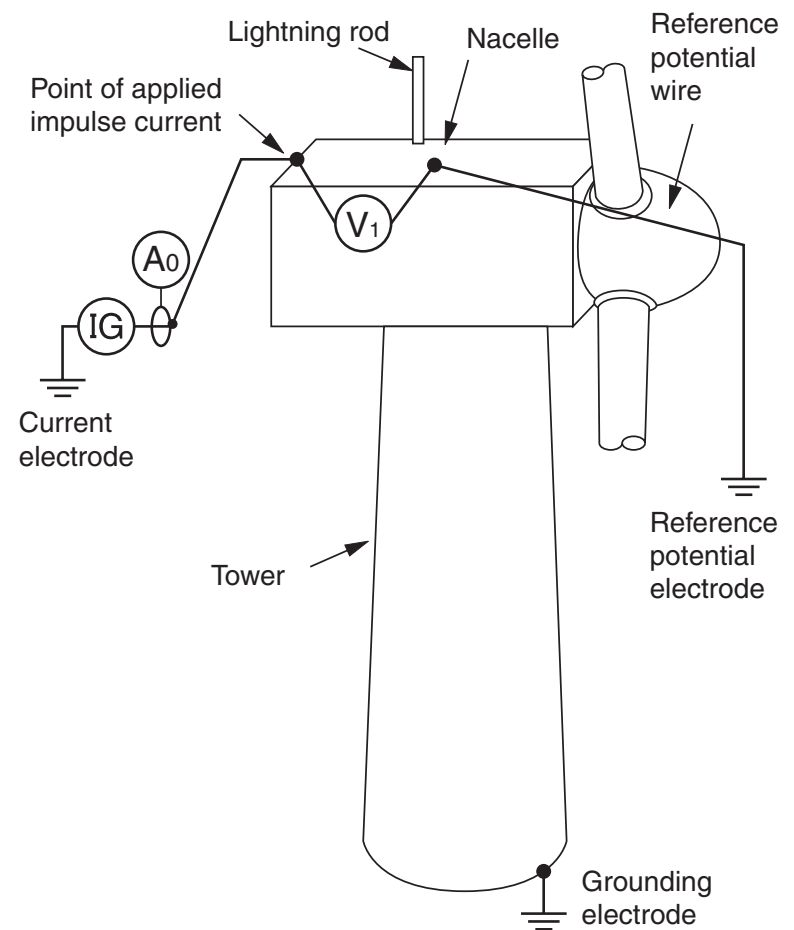
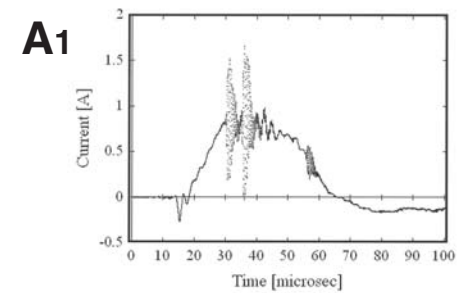
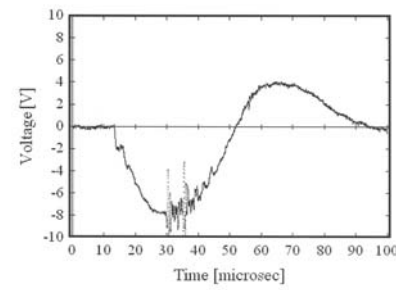
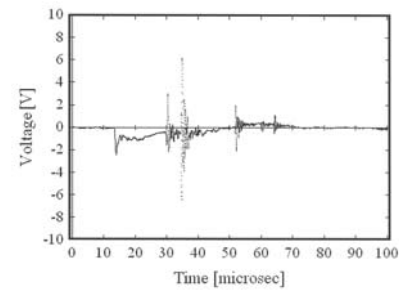
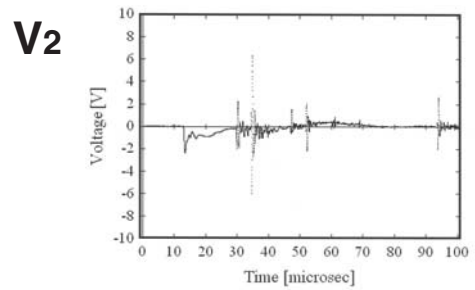
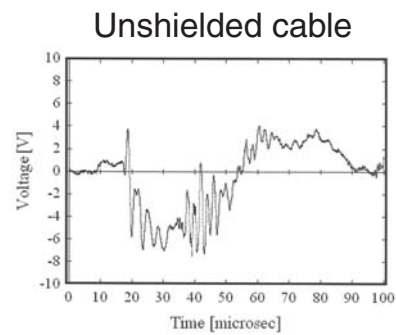
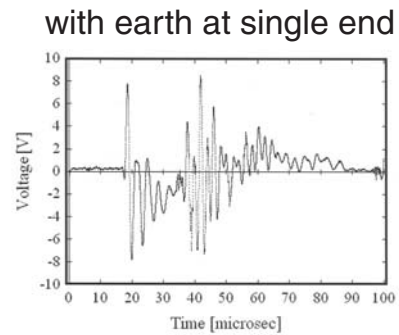
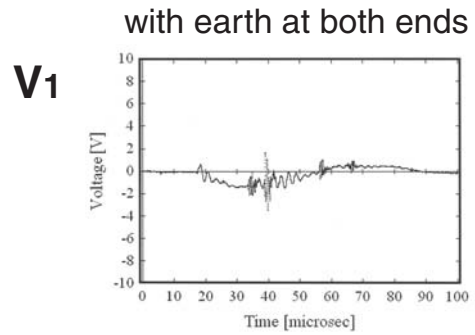
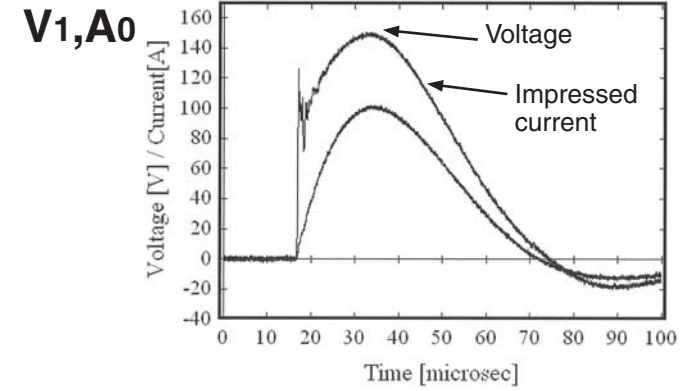
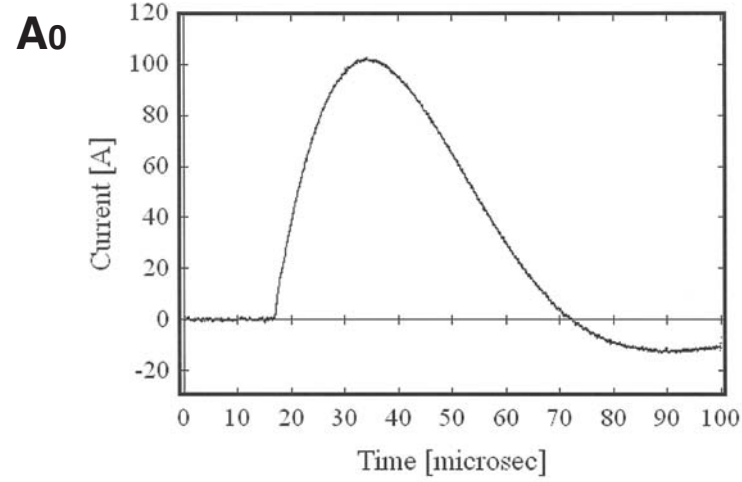


Figure4 Measurement of the potential difference between the nacelle and the reference electric potential point



Shield cable



Discussions

Over voltage generated in equipments inside wind turbine

The generated-voltage: shielded cable \ll unshielded cable

	Shielded cable with earth at both ends	Shielded cable with earth at single end
Tower part	Approximately same	
Nacelle part	Different $<$	

The generated-voltage between the wind turbine body and the core of the control cable occurs by more than one factor.

The factor of the over voltage:

● Inductance of tower. ● Rise in earth potential. ● Electromagnetic-coupling.

When the shielded cable is earthed at both ends, about 1% of the applied current flows as a branch off current . . . About 1% -- flowing though the shield from the tower ---

Potential of the nacelle top:

This potential is the sum of the product, Wave-front steepness of the impressed current \times Inductance of tower ($L \cdot (di/dt)$) , and the product , Impressed current \times earth-resistance

For example . . . Towerunit No.10 in TAPPI wind park

Inductance of tower is 7.9[μ H], Wave-front steepness of the lightning -current is 10[kA/ μ s]

The potential of nacelle part . . . \doteq 79[kV]

Conclusions

If there is some one inside the tower and the nacelle, at lightning strike there is possibility that the potential difference caused by inductance can be impressed to the human body.

• • • **DANGER!**

And,

The equipment may be destroyed, because the voltage generated between the tower and the core of control cable becomes higher than the impulse withstanding voltage of the equipment.

Therefore,

• • • **SPD is indispensable to protect the equipment !**

This time, it examined as an example.

It seems that there are many still not clear points.

Future, we are going to inquire based on this examination results.