49, RUE DE LA BIENFAISANCE - 94300 VINCENNES - FRANCE
SAS AU CAPITAL DE 155 000 € – RCS CRETEIL B 316 719 855
SIRET 316 719 855 00025 – CODE APE 7112B - TVA : FR54 316719855
TEL. : 33 - (0)1.43.28.10.43 – FAX : 33 – (0)1.43.65.43.37

Lightning Protection

Renewable Energy

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1. Wind power

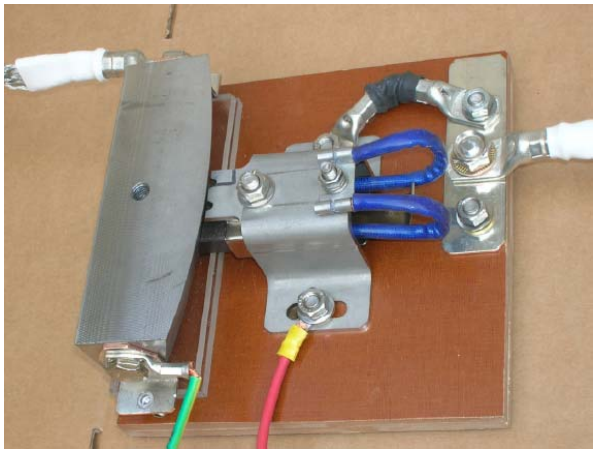
In addition to being familiar with the IEC 61400-24 standard dealing with wind turbine lightning protection, SEFTIM contributed to various projects and addressed various issues regarding lighting protection of wind turbines:

- Lightning impulse withstand tests of wind turbine mechanical components
- Rating of wind turbine earthing systems and measurement of the earthing resistance at low and high frequency
- Influence of blade modifications on the lightning capture and withstand properties
- Improvement the lightning protection system following damage encountered in field on wind turbines

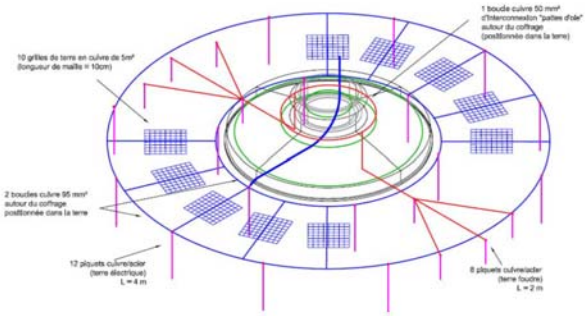
SEFTIM carried out lightning impulse withstand tests for brushes which ensure equipotential bonding between the mobile part of the wind turbine and the fixed part. These bushes ensure the continuity of the earthing between the two parts in order to allow the flow of lightning current without degradation of equipment. The tests were conducted with three steps :

- Preliminary tests aimed at evaluating the impedance of the brush and at determining what was the spark gap flashover voltage
- Test of the device subjected to high current in a specialized laboratory
- Post lightning tests to assess the downgrades due to the flow of lightning current

The tests have shown that the brushes, the ring and the spark gap rather have good behavior in presence of lightning currents. However, the flashover voltage level for the spark gap is relatively high. It has been recommended to modify the orientation of the teeth forming the termination of the electrode.



Test setup



Lightning and electrical earthing

SEFTIM has also conducted pre-design studies for wind turbine farm earthing, using data as the soil resistivity and field tests. Resistivity measurements have shown a big difference for each wind turbines. This was linked to soil differences and soil amendment for each wind turbine. SEFTIM has proposed various solutions for making earthing systems based on the resistivity measurements. The earthing was then validated on the ground with low and high frequency measurements.

Template D

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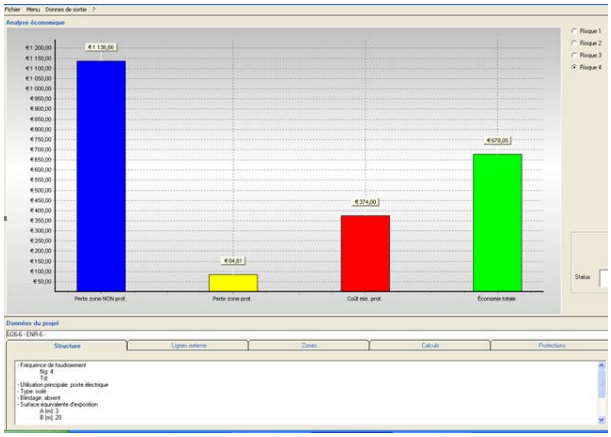
2. Photovoltaic

SEFTIM worked on several projects concerning the degradation of different equipment used in conjunction with solar panels in case of lightning strikes.

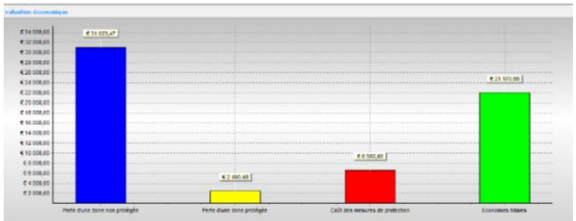
- Determination of overvoltages generated in a cable
- Analysis of failure modes and adapted solutions
- Earthing studies
- Selection and rating of Surge Protective Devices
- Lightning Risk Assessment

In many cases, failures occur in the cables but not necessarily on the DC side of the installation: analog circuits (communication circuits, sensors...) or digital circuitry (erasing the flash memory ...). This damage is mainly due to overvoltage induced after a lightning flash nearby a photovoltaic farm. This is due to loops existing in the electrical installation and to a non adapted earthing system. After analyzing installations and having calculated the lightning induced surges, several solutions were proposed and may differ from one facility to another. Among others, proposed solutions include equipotentiality between different sub-systems, loop area minimization, cable shielding promotion and installation of adapted Surge Protective Devices (SPD).

Solar panels



Risk of loss of production calculated with the Jupiter software



Economic interest of a lightning protection system

Regarding problems existing on the DC part of PV installations (junction box, inverter, batteries) or even the AC part (downstream of the inverter, AC power network connection), specific methods for Lightning Risk Analysis have been developed. The relevance of protection against direct lightning impacts was also studied statistically. The results of these analyzes show that the induced voltages are in most cases more dangerous than direct lightning strikes. It is mainly facilities located at ground level that are most stressed because they are usually wider. The risk becomes significant over a lightning strike density of 2 strokes / year / km². Regarding direct lightning strikes, simple formulas have been developed that allow users to determine the technical and economic interests of lightning protection. The result is also very dependent on the facilities and the lightning strike density. For commercial or industrial installations, the risk of loss of production is generally low. For PV installations located at ground level (photovoltaic farms) the risk is higher and in an area with lightning density between 2 and 3 strokes / year / km² a lightning protection system (lightning rods) investment becomes interesting and makes the ratio cost/benefit advantageous. SPDs must take into account the specificities of photovoltaic installations taking onto account the presence or not of batteries. SPDs have specific ratings especially depending on whether induced surges or direct lightning strikes are taken into account.

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