

LIGHTNING AND OVERVOLTAGE PROTECTION FOR WIND TURBINES

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Wind power plants are high-cost installations, equipped with elements that are very sensitive to overvoltages and overcurrents. Besides their own great height, wind turbines are placed on isolated areas. Their breakage may lead to interruptions in the power supply and their repair is very expensive. For all this, wind turbines contain all factors for being considered as a "maximal risk" structure: their high possibilities of being struck by lightning come together with the high costs associated with their damage. It is therefore essential to protect wind turbines and the enclosed equipment against lightning, thus avoiding also the transmission of overvoltages to other equipment.

The nature and performance of wind turbines makes almost impossible in practice their protection with a conventional system, that is, a fixed air terminal over the structure and connected to the ground, since the blades are 10's meters large and the whole upper part rotates and turns around following the wind direction in order to optimize the energy generation. Using self-standing masts and early streamer emission air terminal is also not practicable due to the huge dimensions, both in height and width, of wind power plants.

In this case lightning protection has to be firstly structural. Wind turbines should be manufactured according to the standard IEC61400 and the bearings should be able to withstand lightning current. But besides the most effective measure for protecting wind turbines against lightning is to achieve a proper grounding and to protect internal equipment and lines against overvoltages.

Aplicaciones Tecnológicas, S.A. supplies all elements for achieving the best protection of wind power plants. Both our lightning protection system components (LPC) and our surge protective devices (SPD) have been tested in independent, official laboratories with currents up to 100kA according to the standards. Our experience of over 20 years in lightning protection allows us to ascertain the best solution for each installation.

EARTH TERMINATION SYSTEM

A good Earth Termination System should let the lightning current to disperse quickly into ground thus minimizing transient overvoltages and current derivations through non-controlled paths.

A good configuration for the earthing of a lightning protection system is vertical electrodes forming triangles, separated a distance larger than their length. The installation of very long electrodes is not efficient for dispersing lightning current since it is an impulse

and therefore it is driven not by the whole conductive mass but only by the external perimeter and up to a certain length.

On another side, wind power plants are often placed on rocky or dry lands, where a low resistance value is difficult to reach. In these cases Aplicaciones Tecnológicas, S.A. recommends the use of our Dynamic Electrodes APLIROD[®], that improves the soil conductivity with the time.

DYNAMIC ELECTRODE AT-25H – APLIROD[®]

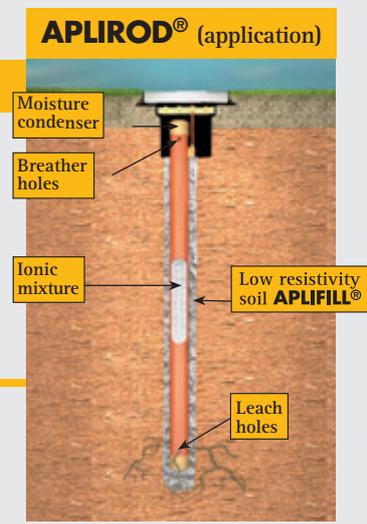
Lightning Protection Systems need an especially stable and low earthing resistance. The absence of free ions in the ground surrounding the electrode has an adverse effect on the functioning of the earthing, thus reducing the efficacy of the whole Lightning Protection System.

Earth Systems with Dynamic or Electrolytic Electrodes are based on the contribution of ions to the ground.

They consist mainly on a hollow copper tube filled with a mixture of ionic compounds. The product absorbs the environmental humidity and is spread in the ground surrounding the electrode, thus adding free ions and gradually reducing earth resistivity.

The efficacy of this electrode is enhanced if the electrode is surrounded by a ground conductivity improver.

AT-25H	
External diameter	28mm
Length	2,5m (vertical)
Drilling	Ø40mm x 3m.
Filling	0,5kg of APLIFILL.



EARTH TERMINATION SYSTEM

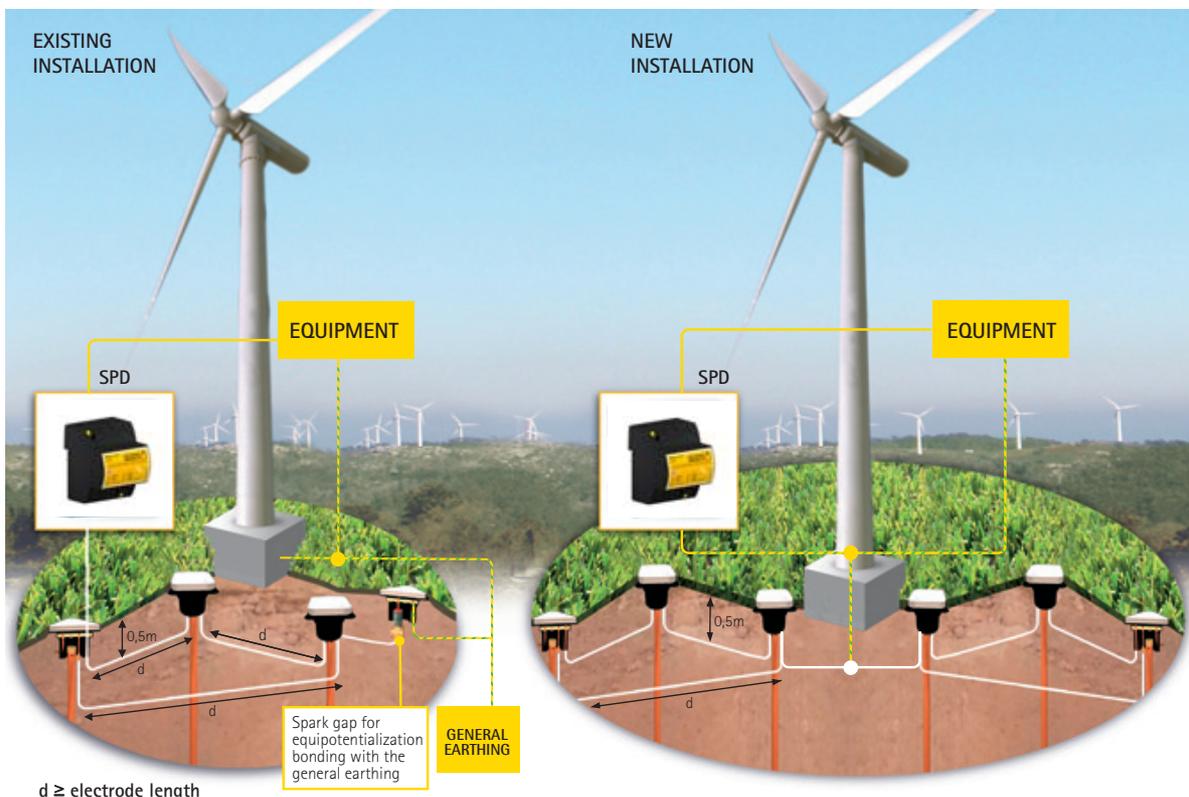
For later measurements the earthing will be connected using an equipotentialization bonding bar placed inside an inspection pit. Besides, each dynamic electrode should be placed inside an inspection pit for avoiding the breather holes to get blocked. Electrodes will be configured in triangle, separated at least 2,5m and bonded with 30x2mm tin-plated copper tape. Tape has larger surface for the same amount of material than cables and therefore has less resistance, less inductance and generates less electric fields.

In case of new installations, the best option is a common earthing for the equipment and the lightning

protection, with low inductance, well-controlled and integrated in the structure.

However, lightning protection often has to be installed on existing plants where the earthing for the equipment is already done. In this case it is recommended to make an independent earthing and to connect them using an isolating spark gap. Then the earthing of the lightning protection system remains isolated in normal conditions, causing no problems such as electromagnetic noise or corrosion.

When there is a lightning strike then the spark gap connects both earthing systems thus avoiding dangerous potential differences.



EARTH TERMINATION SYSTEM COMPONENTS



AT-025H

Dynamic electrode APLIROD, vertical, Ø2500x28 mm.



AT-052D

30x2mm tinned-copper tape.



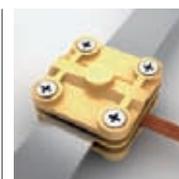
AT-010H

Polypropylene inspection pit, 250x250x250mm, able to withstand 5000 kg.



AT-020H

Brass bonding bar for equipotentialization and testing. To be placed inside inspection pit. Connectors for Ø8-10mm and/or 30x2mm tape.



AT-020F

Brass clamp for straight, cross, "T" and parallel connection for Ø8-10mm and/or 30x2mm tape.



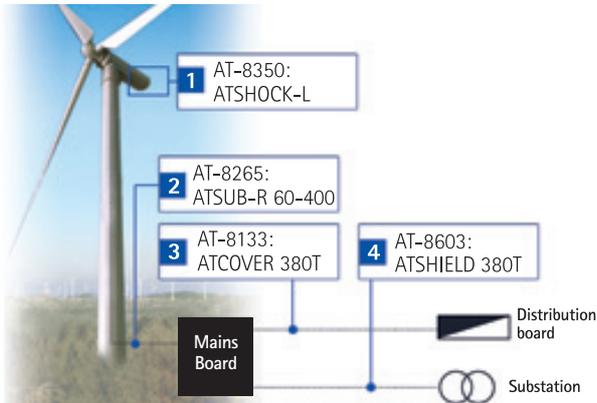
AT-050K

Isolating spark gap for earth bonding. Withstands de 100kA (10/350µs).



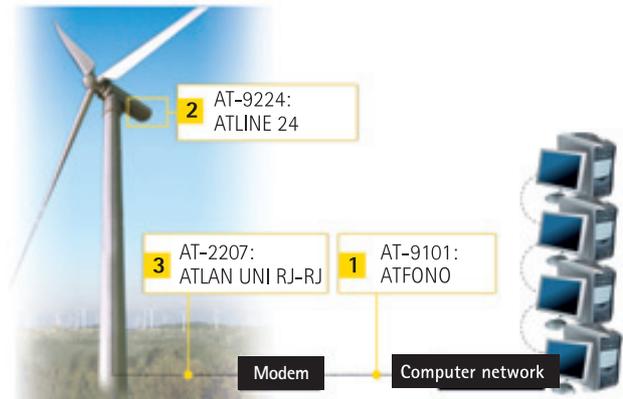
PROTECTION AGAINST OVERVOLTAGES

Power supply and telecommunication lines enterign and leaving the diferente equipment of wind power plants should be protected against overvoltages.



PROTECTION OF POWER SUPPLY LINES

For the protection of the power supply lines it is recommended to install an ATSHOCK-L (1), able to withstand 100kA lightning current, inside the wind turbine. This protector will derive most of the energy to the ground. In order to avoid a high residual voltage to the mains board at the base then a second coordinated protector is recommended: one from the ATSUB (2) series. If the generated energy is connected to the electric network then this output should be protected with an internally coordinated protector form the ATSHIELD (4) series. However, if that energy is used as power supply for sensitive equipment then it is recommended to employ a protector from the ATCOVER (3) series, since their residual voltage is lower.



PROTECTION OF DATA LINES

For the protection of data lines it is recommended to install a protector from the ATLINE (2) inside the wind turbine in order to protect the control and measurement lines such as the ones connecting tachometers, weather vanes and thermometers.

It is recommended to install an ATLAN (3) protector for the ISDN line at the base of the wind turbine and at the modem input. The connection between the modem and the computer network is recommended to be protected with an SPD withstanding a higher discharge current such as ATFONO (1).

CHARACTERISTICS OF THE SPDs TO BE USED

PROTECTION OF POWER SUPPLY LINES



1. AT-8350: ATSHOCK-L

Single-Phase protector, able to withstand a peak current of 100kA per pole with a 10/350 μ s wave letting a residual voltage lower than 4kV.



2. AT-8265: ATSUB-R 60-400

Single-Phase protector for 400Vac, able to withstand a peak current of 60kA per pole with a 8/20 μ s wave letting a residual voltage lower than 2,5kV. With remote control connection.



3. AT-8133: ATCOVER 380T

Three-Phase protector both common and differential protection, able to withstand a peak current of 30kA per pole with a 8/20 μ s wave letting a residual voltage lower than 900V. With light alarm and remote control connection.



4. AT-8603: ATSHIELD 380T

Three-Phase protector against direct lightning strikes using combined technology, able to withstand a peak current of 30kA per pole with a 10/350 μ s wave letting a residual voltage lower than 1,5kV.

PROTECTION OF DATA LINES



1. AT-9101: ATFONO

Telephone line protector with 130V_{DC} nominal voltage, able to withstand a peak current of 20kA per pole with a 8/20 μ s wave letting a residual voltage lower than 330V.



2. AT-9224: ATLINE 24

Data line protector with 24V_{DC} nominal voltage, able to withstand a peak current of 20kA per pole with a 8/20 μ s wave letting a residual voltage lower than 31V_{AC, DC}.



3. AT-2207: ATLAN UNI RJ-RJ 1000BASE-T

Individual computer network protector provided with RJ45 input and output connectors, able to withstand a peak current of 2kA per pole and reaching speeds up to Gbit/s.



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