Wind turbine plant of Nadachi

North-West Coast of Japan

Indelec
lightning protection

Damages on a wind turbine due to lightning strikes.

This experiment is carried out on the Nadachi wind turbine on the west coast of Japan and is designed to measure the effectiveness of lightning protection afforded by a Prevectron early streamer emission lightning conductor manufactured by INDELEC.

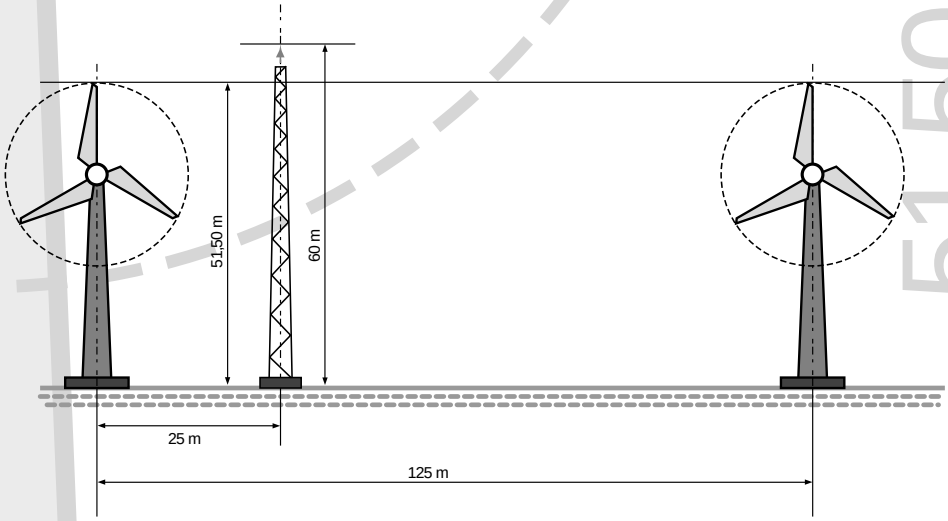
The experiment started in November 1997. For the last 5 years, scientists and engineers in Japan are recording impressively intense and frequent lightning strikes on the site and study the efficiency of the Prevectron air terminal in such extreme conditions. These results are presented regularly in Scientific Conferences on Lightning or Wind Energy.

Introduction of the site

The plant consists of two three-blades, horizontal-axis turbines, with a maximum height of 51.5 m. Each blade is approximately 10m long and is made of a composite material. When the site was inaugurated in December 1996, no specific provisions were included in the design for protection against direct lightning strikes.
The site is located in a region notorious for winter storms with a keraunic level of between 30 and 35. However, the storms specially occur during the few winter months and July/August.
The lightning flash density is then very important during these months. Moreover, the number of lightning strike is sometimes very important in a very short period of time, up to 8 to 10 strikes in less than 3 hours.
Thus it was that in January 1997, the turbines sustained substantial damage from a series of violent thunderstorms: mechanical (broken blades), electrical (irreparable damage to electrical and telephone systems) and computer-related.

The lightning protection system

In November 1997, a Prevectron S6.60 type ESE lightning protection system was installed by CENTRAL LIGHTNING PROTECTION Inc. (Japan) on a 60-meter mast, positioned between the two turbines, 25 meters from one and 100 meters from the other.
The Prevectron ESE device was set 8.5 meters higher than the highest point reached by the blades as they turn, or when at rest at their highest position.



Instrumentation and testing

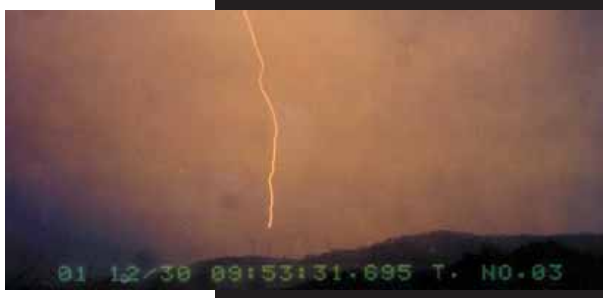
At the same time, an automated monitoring station was positioned 1 km away. A special optical and mechanical twin-shutter camera allows the lightning to be photographed very quickly. The 35 mm film used contains 700 exposures, giving an autonomy of approximately 3 months. The films are time stamped using a GPS satellite signal.

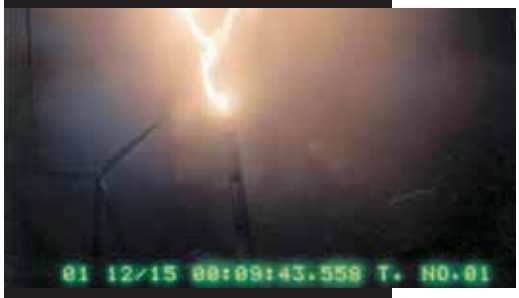
Results

This report presents the results of more than 4 years of monitoring from 1st quarter 1998 to 1st quarter of 2002 with dozen of exposures showing cloud/ground flashes. A few example of pictures are presented in this brochure.

In 1998, of the 32 impacts - most of which were of the upward type - 29 were caught by the ESE protection system, thereby avoiding considerable damage to the generators and auxiliary equipment. 2 impacted the turbine closest to the protection system and one impacted the turbine farther away. However, the three probably low intensity impacts that hit the generators only cause traces at the surface of the blades, but no structural damages to the turbines.

In December 2001, the Prevectron S6.60 has been changed to a Millenium type, the latest version developed by INDELEC engineers, based on the results of research in real-lightning conditions conducted by the company for the last 10 years.
12 lightning strikes have been recorded on the site from December 14 to December 30 with an impressive 100% success rate for the Prevectron Millenium (the 12 strikes were caught by the ESE air terminal).





Conclusion

These monitoring campaigns, carried out on an industrial installation demonstrated the effectiveness of the protection afforded by a Prevectron ESE lightning conductor and show a good correlation with the theoretical model.

Assessment of a wind's turbine protection requirements indicates a level of protection II, thereby providing an efficiency of between 90 and 95%.
The results are consistently showing that the efficiency of the Prevectron LPS is above the 90% mark.
The latest campaign results even show an increased efficiency with the Millenium version.

Finally, it should be remembered that the electrogeometrical model of the standards IEC 1024-1 and NFC 17-102 as well as BS and NFPA standards is based on downward negative lightning strikes.
It is interesting to check the model is also valid for upward (probably positive) strikes recorded during these experiments in Nadachi - Japan.

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