

SUMMARY NOTE OF THE ARTICLE:

“A study of upward positive leaders based on simultaneous observation of E-Field and high-speed images”, Nobuyuki Takagi, Daohong Wang, Teiji Watanabe, Gifu University (Japan), IEEJ Trans. FM, Vol. 126, No.4, 2006.

This article deals with measurements of the speed of upward leaders at two different sites located in Japan, carried out in 2001 and 2003 in the Hokuriku area, in Nadachi and Mikuni. These sites are located in a heavily struck area. The keraunic density is approximately 2 lightning strikes per km² per year. However, lightning storms are very concentrated in winter in this area, as evidenced by the 62 events recorded by the measurement systems put in place during the two lightning storm seasons.

The Nadachi site takes the form of two 50 meters high wind turbines, protected by a 60-meter pylon nearby. The Mikuni site is characterized by two thermal power plant chimneys, 150 and 200 meters high respectively.

The measurement device consists of an Automatic Lightning Progressing Feature Observation System (“ALPS”) that points toward the top of the monitored structures, and an electric field antenna. The ALPS system makes it possible to obtain high-speed images of the progress of the upward leaders. The broadband antenna makes it possible to correlate observations with the polarity of the electric field and its dynamic evolution. The speed of the upward leaders is determined using high-speed images produced by the ALPS systems optical sensor.

Of the total of 62 recorded events, 9 can be used by the measurement system. These events are identified as upward leaders coming from the chimneys and the pylon of both sites. The measured velocities of the upward leaders show either a constant propagation speed or a speed that accelerates with height. The average speeds of the first site range from 5.3×10^5 to 1.8×10^6 m/s, while for the second site, the speeds are a bit slower ranging from 3.9 to 6.9×10^5 m/s. The average of the measured speeds of the upward leaders from the first site is 1.07×10^6 m/s. The average of the upward leader velocities measured from the second site is 0.54×10^6 m/s.

We can observe through these results that the second site produces upward leader speeds that are half lower compared to the first site. This difference in average speed of propagation of upward leaders between both sites could come from the large difference in height of the structures concerned: 50-60 meters and 150-200 meters. These average speeds of propagation of upward leaders are consistent with the average speed indicated in paragraph §5.2.3.2 of the lightning protection standard NF C 17-102 relating to Early Streamer Emission Air Terminal, which is 10^6 m/s.