Sessions 4a, 4b, 4p

LIGHTNING ATTACHMENT

Moderator's report

Prof. T. Horváth (H)
chairman

Prof. R. Wlodek (PL)
moderator

LIGHTNING ATTACHMENT MODELS

A 3-d numerical model of negative lightning leader interception. – Applications to the collection volume construction.

S. Ait-Amar – G. Berger.

Oral session 4a.1

To simulate the propagation of the downward and upward leaders towards each other, this model considers the ratio of the downward leader velocity to that of the upward leader.

It is stated that when several rods are installed, the launch of an upward leader at the tip of one them strongly influences the conditions for leader inception at the other rod tips.

A comparison with results of other models showed different levels of protective effects.

A dynamic model of the lightning attachment process.

I. Nissenbaum – B. Nissenbaum – I. Izraeli – A. Braunstein.

Poster session 4p.1

The preliminary results of the proposed dynamic theoretical model shows that this model has the basic features, which describe the lightning attachment process. It is fundamentally a two-dimensional model of leader propagation.

Only after the proposed model will be extended to three-dimensional structures and will be refined to include more details of the lightning discharge physics.

Lightning striking frequency simulation and effect of lightning rods.

T. Shimosako – N.J. Vasa – S. Yokoyama.

Poster session 4p.2

It is a simulation of the leader propagation using the Monte-Carlo method. A new result is that vertical lightning paths give more optimistic protection efficiency of a lightning rod than inclined lightning paths.

Protection failure occurs more frequently by lightning with a small peak value than by one with a larger peak value. Small protection angles offer better protection efficiency than large protection angles.

A quantitative study of lightning striking distance factors.

I. Fofana – A. Béroual.

Poster session 4p.3

From the analysis it is suggested that any model for lightning interception must take into account both earth structure geometry and lightning parameters such as the downward leader velocity and charge per unit length of channel.

The intensity of electric field, required for air breakdown, varies directly with air pressure and humidity for example in high altitude.

Comparison of partially- and fully-probabilistic models of lightning attachment and a proposed laboratory test.

F. D'Alessandro – N.I. Petrov.

Poster session 4p.10

This paper presents results from recent studies involve the additional step of using fractal theory to model the tortuosity and branching of the leaders.

Some statements are as follows. For any given structure, the interception probability is higher for negative lightning strikes than those of positive polarity. The shielding zone of two neighboring lightning rods is larger than the combined shielding zones of two individual rods. Most side strikes appear to be due to positive discharges. The breakthrough probability of positive lightning is higher than for negative lightning.

A new test uses ultra-long, free ranging sparks in air, which are analogous to low-intensity lightning discharges.

PROBLEMS OF EARLY STREAMER EMISSION

An experimental study of leaders initiated by single and advanced (ESE) lightning rods. Triggering site of Cachoeira Paulista (SP) Brazil.

A. Eybert-Bérard – B.Thirion – P.Boilloz – M.Saba – N.Solorzano.

Oral session 4b.1

Several electrodes are compared by triggered lightning strokes and laboratory experiments.

- recording of the upward currents on the ESE rod, who can be considered as being an upward streamer. In same time no evidence of upward streamer at the tip of the single lightning rod.

- two events from automatic video cam, showing natural upward streamers on the ESE rods.

The number of events is still too low and collation for more results are required, to draw any meaningful conclusions.

Critical analysis of the lightning attachment models and perspectives to realise an improved model.

A. Bedja – P. Auriol – F. Buret – O. Fulchiron.–
Y. Henaff.– A. Rousseau.

Oral session 4b.2

The paper compares several models dealing with lightning interception and finally propose a new one to study the evolution of the space charge under variable electric field in time,

The aim of the model is to find a new criterion of initiation and propagation of the ascending leader which depends on both the geometry of the structure and the variations of the space charge.

Comparative testing of ionizing and non-ionizing air terminals under quasi static electric fields.

A. Galván – A. Alcántara.

Oral session 4b.3

Nine air terminals were tested in order to assess their capability of generating emission currents (dissipation currents) when they are exposed to high dc electric fields.

For the ionizing air terminals, their behavior is better at higher gaps. In general, positive polarity generated higher emission current levels.

The best non-ionizing air terminal regarding emission current levels was, in some arrangements, better than the ionizing air terminals.

Even though the corona inception levels were quite different for the ionizing and non-ionizing terminals , the dispersion on the breakdown voltages was only about 10%, which means that the breakdown voltage is practically not dependent on the operation criterion of the air terminals, at least not more than the dependence of the geometry.

The striking distance of lightning flashes and the Early Streamer Emission (ESE) hypothesis.

V. Cooray – N. Theethayi.

Oral session 4b.4

In this paper the striking distance as a function of peak current is evaluated for a large number of vertical conductors of different heights and radii.

Based on these results the ESE hypothesis is investigated. The results cast doubt on the validity of the ESE hypothesis.

This in turn calls for more experimental data and field validations before using the ESE hypothesis in standard lightning protection practice.

CORONA AND SPACE CHARGE

A method to calculate the number of lightning strikes to a high object taking into account gas discharge processes near its tip

N.L. Aleksandrov , E.M. Bazelyan , R.B. Carpenter , Jr., M.M. Drabkin , Yu.P. Raizer

Oral session 4b.5

Taking into account corona space charge, the model is used to calculate the radius of attraction of downward and upward lightning discharges to a high ground object. It is shown that a multi-point corona-producing system mounted on a high object can reduce drastically (or even practically eliminate) the number of lightning strikes to it.

Corona discharge in lightning rods under impulse voltage: An analysis tool for the investigation of charge emission.

P. Llovera – J. M. Lázaro – A. Quijano – J. A. LLiso.

Poster session 4p.6

The paper presented the results of measurements on the corona current emission produced by impulse voltage. It was sometimes stated that after an early current impulse period followed without any-discharge. The behavior of pointed and bunt electrodes are compared. Beside the earthed rod electrodes have been studied with a spark gap inserted into the earthing path.

The laboratory experiments were performed with electrodes of small dimensions and small gap.

Corona current impedance, a possible relation between applied electric field and measured current in earthed needles of different shape.

L. Arévalo – O. Díaz – C. Gómez – H. López – F. Román

Poster session 4p.7

In the studied cylindrical coaxial arrangement a DC current component associated with the presence of a corona-electrode which was immersed in the electric field was observed.

The study is only indirect connection with initiation of connecting leader.

On attempts to protect a structure from lightning strikes by enhanced space charge generation.

V. Cooray – M. Zitnik.

Poster session 4p.5

Neither the geometrical effect nor the space charge generated by the corona element can reduce the striking distance of a given tower below a certain critical value which depends only on the charge on the stepped leader. Thus, the corona element will not be able to prevent a lightning flash terminating on the tower.

PROTECTION OF BUILDINGS

Optimum design of lightning protection system in a clustered building environment.

Z. A. Hartono – I. Robiah.

Oral session 4a.3

The study of struck point distribution in a clustered building environment shows that they are concentrated mainly on the outer points, corners and edges of the building cluster. This suggests that for a clustered building environment, their protection against lightning strikes can be effectively obtained by installing air terminals mainly on the outer perimeter of the cluster. This can significantly reduce the components required to protect the buildings from direct lightning strikes and hence lead to a reduction in the total costs.

Guidelines for the placement of air terminations near vulnerable points on structures

F. D'Alessandro

Oral session 4a.2

This paper describes the results of a preliminary series of lightning electric field calculations carried out to give a quantitative guideline for the maximum distance at which air terminations should be installed from the vulnerable points of structures, such as edges and corners.

Computer simulation of the effect of dimensions on the efficacy of a lightning rod

N.L. Aleksandrov , E.M. Bazelyan , F. D'Alessandro , Yu.P. Raizer

Poster session 4p.4

A numerical simulation showed that the efficacy of a lightning rod is almost independent of the rod radius in the range 0.05 - 5 cm, whereas lightning attachment to a rod of a given length depends on whether the rod is mounted on the ground or on the roof of an object. Hence, it is difficult to increase the efficacy of a lightning rod through earlier initiation of streamers from the rod top.

Characteristics of lightning flashes striking the CN tower below its tip

A.M. Hussein, W. Janischewskyj, F. Noor, M. Milewski

Poster session 4p.8

In this paper, visual records of lightning flashes striking the CN Tower during a 10-year period were analyzed. The tower was struck by lightning 13 times below its tip in comparison with 358 strikes to the tip. The strike distance from the tip ranged from 4 m to 56 m.

Statistical analysis of the flash characteristics of strikes below the tower's tip generally shows that the number of strokes in a flash as well as the flash duration are lower in comparison to those for the majority of cases when the tower is struck at its tip.

ELECTRIC POWER LINES

The use of leader progression model to predict lightning incidence in power lines.

J. Tarchini.

Oral session 4a.5

Several simulations had been performed, considering different structure heights and their location in complex terrain shape, such as at the side or the top of a hill or mountain.

From simulation results, new formulas had been performed for calculating the lateral striking distance. The proposed formulas are expressed in terms of main structure and terrain parameters: tower height and hill angle.

Experimental study of rod height and impulse polarity impact on the protection zone.

S. Grzybowski – Y. Song.

Oral session 4a.4

The striking distance to a grounded object is longer than to ground directly for negative lightning impulse, and shorter for positive lightning impulse.

The lightning protection zone of the Franklin Rod can be expressed by an elliptical model. The calculation result is very close to the experiment result obtained with 1.2/50 impulse in laboratory.

The lightning protection zone of the Franklin Rod under negative polarity impulse is larger than positive polarity impulse.

Numerical investigations of lightning proofness of UHV overhead lines.

A.S. Gaivoronsky, K.V. Karasyuk, E.N. Prokofyeva.

Poster session 4p.9

This study is based on the "lightning leader orientation" model. This describes the lightning leader propagation as a random process taking into account stochastic deviations of its trajectory and the development of upward leaders from overhead line conductors.

It was shown that the distribution of lightning current essentially differs for the strokes in the conductor from the initial distribution lightning strokes. The median current is always less than for the initial distribution (30 kA) and it decreases, if the probability of the shielding failure decreases.

The results of the numerical modeling are compared with the observed data. The comparison is based on 100 thunderstorm hours/year.