28th International Conference on Lightning Protection

Topic V: Lightning Downconductors and Earthing Moderator's Report

Chairman: C. Bouquegneau *The Faculté Polytechnique de Mons, Belgium*
Moderator: W. Hadrian *Vienna University of Technology, Austria*

I. Session V-A: Practical problems

V-1 "*Triggered-Lightning Testing of the Protective System of a Residential Building: 2004 and 2005 Results*", B. A. Decarlo, V. A. Rakov, J. Jerauld, G. H. Schnetzer, J. Schoene, M. A. Uman, K. J. Rambo, V. Kodali, D. M. Jordan, G. Maxwell, S. Humeniuk, M. Morgan

Triggered lightning is useful to test lightning protection systems. The paper reports about measured current distributions in two different test houses carried out in the years 2004 and 2005. The goal of the tests was to measure the current distribution between the grounding system of the test houses and remote ground (neutral of a power supply cable).

V-2 "*Experimental verifications on the use of natural components of structures as a part of a LPS*", H. E. Sueta, G. F. Burani, D. M. Leite, J. A. B. Grimoni

The use of natural component as a part LPS is an important economic problem. Three structures where tested. Metallic tiles (0,7mm and 0,55mm) used as a part of the air-termination system, steelwork with reinforced concrete columns and reinforcing steel in building foundations. One interesting result: To prevent perforation of metallic roof-tops air terminations are recommended.

V-3 "*Evaluation of Steelwork Continuity and Review of utilizing Steelwork as a Down-conductor in Reinforced Concrete Apartment Structures*", K.-H. Lee, J.-B. Lee, S.-H. Chang

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For lightning-current-carrying connections welding or clamping is necessary. Lashing wires can exploit and damage the concrete. A parallel down-conductor system is proposed, since in practice it is difficult to weld or clamp the steel bars during construction of a building.

V-4 "*Laboratory and field corrosion tests on earthing rods for LPS (Lightning Protection Systems)*", M. Lobota, R. Marciniak

Corrosion of earthing electrodes is an often neglected problem. Therefore it is necessary to carry out corrosion tests. The results of laboratory tests with different protective coatings and field tests in different types of soil are reported. The field tests started 2003.

V-5 "*Overvoltage Protection of Large Power Transformers- a real life study case*", C. L. Bak, K. E. Einarsdottir, E. Andresson, J. M. Rasmussen, W. Wiechowski, J. Lykkegaard

During a heavy thunderstorm in Denmark a 400/150kV transformer was damaged. To study this incident a simulation model of the transformer and its surrounding (ZnO surge arrester, earthing grid) was made. The simulation showed that the front time of the lightning currents and the soil resistivity have a great influence on the tolerated lightning current. Furthermore the transient performance of the earthing grid has a great effect on the amplitude of the overvoltage at the transformer terminal.

V-6 "*Retractile Grounding Cable Used for Floating Roof Tanks: Four-Year Experience*", A. Galván

In the last 40 years 242 accidents of storage tanks were reported. About 74% occurred in petroleum refineries, oil terminals or storages. 80 accidents were caused by lightning. Great problems are floating roof tanks because the floating roof has often no sufficient electrical contact with the tank shell. Therefore a high potential difference can occur by direct and indirect lightning strikes. A retractile grounding-cable device is proposed between the grounding roof and the tank shell.

V-7 "*Investigation of the Influence of Distribution Line Grounding Configurations on Lightning Overvoltages*", F. S. Almeida, S. Visacro, J. C. S. Ventura, J. V. P. Duarte

Intensive lightning activity (3-12 strokes/km²/year) and a soil resistivity of about 2500 Ωm causes critical problems in Brazilian southeast area. It is necessary to find efficient grounding configuration in such critical areas. Various configurations have been simulated systematically and new configurations have been proposed.

II. Session V-B: Theoretical problems

V-8 "*Ground Resistance versus Ground Impedance*", A. J. Surtees, A. Rousseau, F. Martzloff

Ground resistance characterise the behaviour of lightning earthing system only at low frequencies. But lightning discharge is an impulse phenomenon which has a broad frequency spectrum up to 1 MHz. Therefore it is necessary to use a more accurate model of grounding systems with distributed resistive, inductive and capacitive elements. Normally the grounding behaviour is represented by the "impulse impedance". Another way is to measure the impedance at various frequencies up to 1 MHz.

This paper compares the different methods for characterizing the behaviour of complex lightning grounding systems.

V-9 "*Counterpoise impedance with lightning discharge. Critical, effective, minimal impedance lengths. Technical considerations*", B. Hermoso

There are different concepts related with the length of the electrode length. The paper presents an analysis of the influence of the following parameters: soil resistivity and frequency.

Conclusion of the author: The best concept for power and lightning application is the minimal length.

V-10 "*FDTD Simulation of a Horizontal Grounding Electrode and Its Equivalent Circuit Modelling*", M. Tsumura, H. Yamamoto, Y. Baba, N. Nagaoka, A. Ametani

The finite-difference time domain method is used to analyse three testing arrangements for horizontal grounding electrodes. The influence on the evaluated transient response is not significant (6%). The initial peaks of the voltage calculated with the FDTD method is also compared with a calculation (EMTP) using Sunde's equivalent circuit. The initial voltages using Sunde's equivalent circuit are 10% to 20% higher. A modified equivalent circuit with an additional branch is proposed.

V-11 "*Lightning Impulse Property of Vertical Grounding Rod*", J. He, R. Zeng, Y. Li, B. Zhang, W. Zhuo, L. Wang, Y. Deng

The authors propose a model consisting of three simple equations. Therefore the model can be easily used in EMTP and other transient analysis programs. The agreement between the experimental and analytical results is good.

V-12 "*Development of Calculation Model for Grounding Resistance of Rod Electrodes exposed to Large Lightning Impulse Current*", Y. Asaoka, H. Motoyama, H. Matsubara

Large lightning currents can generate soil ionisation surrounding the grounding rod. To simulate the ionization effects the conductor radius of the grounding rod is considered time-variable. Therefore the electrical parameters of the equivalent circuit are time-variable especially the capacity C and the conductance G. The influences of soil resistivity, rod length and lightning current on the transient response are discussed.

V-13 "*Pspice modelling of a special insulated down-conductor*", F. D'alessandro, F. Alghusain

It is often difficult to control the separation distance between the down-conductors and conductive structural elements inside of buildings. A new solution is insulated down conductors to avoid uncontrolled side flashes. A special construction with a semiconductive outer shield is modelled and simulations have been carried out by Pspice simulations.

V-14 "*Induced Magnetic Field Inside of Directly Stricken Building by Lightning*", S. Miyazaki, M. Ishii

The current distribution in the vertical columns and horizontal beams can be used to calculate the spatial distribution of dH/dt. An even current distribution in the vertical columns reduces dH/dt. Therefore the authors propose to cover the top of the building with mesh to provide a good current distribution of the lightning current in the vertical columns.

III. Session V-P: Poster session

V-15 "*Study on Simulation Model of Lightning Hit to Ground to Calculate Lightning Overvoltages in Residence*", S. Sekioka, K. Mori, N. Fukazu

The goal of this paper is the estimation of overvoltages in residences caused by lightning hit to ground nearby. The proposed model uses Thevenin's theorem. The results of the simulations are compared with measurements.

V-16 "*Experimental Study on Transient Grounding Resistance of Vertical Electrodes*", H. Motoyama

This paper reports experimental studies on transient grounding resistance of vertical rods (30m). The time and the frequency response are compared. Measured GPR (ground potential rise) distributions on the ground surface are documented.

V-17 "*Lightning Impulse Characteristic of Humus Soil*", B. Zhang, J. He, B. Zhang, R. Zeng

To calculate the earthing resistance it is necessary to measure the parameter of different soils. In this paper the characteristics of humus soil (soil with organic material) and sandy soil are compared (resistance, critical break down field).

The soil resistivity is mostly determined by the water in the soil and strikes, when the soil loses water the resistivity increases.

V-18 "*High frequency measurements of grounding impedance on resistive soil*", P. Llovera, J. A. Lliso, A. Quijano, V. Fuster

High frequency measurements were carried out in laboratory with a small scale sperial symmetric set- up. To study the impedance behaviour at different conductivity of soil, distilled water with added ions was used. Up to 1 MHz the impedance show a capacitive component. The real scale measurement set up was also symmetric. The studied rod was in the centre of a circle. A set of rods (varied from 1 to 7) was distributed on the circumference. The behaviour of the impedance is also capacitive up to 2 MHz (for 3 and more rods).

V-19 "*Evaluation of lightning protection earthings by their frequency and impulse properties*", S. Wojtas, A. Rousseau

Three types of earthing were tested (vertical earthing: 10 m and 50 Ωm, horizontal buried earthing: 70 and 50 Ωm, meshed earthing: 130 Ωm) and compared with model calculations. The impulse measurements were performed with two standard times of rise (1µs, 4 µs). The high frequency tests were carried out in the range between 10 Hz to 1 MHz.

V-20 "*Quasi-static approximation of concentrated ground electrodes: experimental results*", D. Romero, J. Montanyà, J. Montañá, D. Garriga, V. March, R. Miranda

Three models of vertical rods were studied: the lumped circuit, the uniform distributed-parameter circuit and the hybrid electromagnetic model (HEM). The field measurements and the model results are compared. For this reason the measured real current waveform has been applied to the theoretical models. The three models show a good approximation of the measured results.

V-21 "*Variation of soil resistivity and ground resistance during the year*", I. F. Gonos, A. X. Moronis, I. A. Stathopulos

The accurate analysis of grounding systems requires determination of earth's structure parameters such as soil resistivity and thickness of layers of the soil. A two layer earth structure is used for the investigations

V-22 "*Study of induced electric current in the ground at the lightning - around the seismic fault zone-*", T. Tambo, H. Sakai, T. Nagao

V-23 "*Study of remanent magnetization of fulgurite*", H. Sakai, K. Kumazaki

The papers V-22 and V-23 are not in the scope of this conference, but it is interesting to read about investigations about the magnetic properties of fulgurites and geoelectric potential changes in relation to local lightning activities.

V-24 "*Effects of Rain and Snow on Electromagnetic Radiation of Grounding Systems*", S. A. Mosaddeghi, A. Shoory, S. H. H. Sadeghi, R. Moini

The authors modelled a 40 x 40 m² grounding system. Three cases were simulated: homogeneous ground, rainy ground and snow covered ground. The influence of rain is greater than of dry snow.

V-25 "*Effective Length and Impedance of Grounding Electrode for High Frequency Current*", H. Sakurano, A. Ohtsubo, M. Minowa, T. Takashima

This paper presents effective lengths and grounding impedances of horizontal electrodes composed of linear conductors. Effective lengths and grounding impedances are computed by the current simulation method. It is pointed out that, as the earth resistivity increases one hundred times, the grounding impedance increases about ten times, for high frequency current of 200 kHz, whereas the grounding resistance increases one hundred times for power frequency current.

V-26 "*Keeping Separation Distances by Use of Insulated Downconductors -Application and Experiences-*", R. Brocke, P. Zahlmann

This paper presents the application and the design rules for the use of insulated down-conductors. An appropriate test method is applied to determine an equivalent separation distance. By using calculations as well as experimental verifications, different arrangements have been approved to allow an efficient protection of antenna systems or tall structures like silos. It is shown that the insulated downconductors have new possibilities to protect buildings.