Mons (Belgium), June 10th 2004

To Prof. W. HADRIAN
Budinskygasse 32
A-1190 WIEN

FAX: **00 43 1 320 66 01**

Dear colleague and friend,

Thank you very much for your 2 e-mails containing your excellent moderator's report and the suggested partitioning of the ICLP2004 Session 5 papers.

I completely agree with your proposal and just propose below a somewhat different English writing. I hope you will agree with me so that I can send your report to the Organizing Committee.

Thank you very much again.

Very friendly yours,

Christian

Prof. Christian Bouquegneau,
Prorector of the FPMs,
Rue de Houdain, 9, B-7000 MONS (Belgium)
Phone : 32 65 374040 ; Fax : 32 65 374045 ;
e-mail : christian.bouquegneau@fpms.ac.be

Sessions 5a, 5b, 5c, 5p

Moderator's Report

SESSION 5a

High Voltage Transmission Towers and Broadcasting Stations

5a.1 Lightning current distribution to ground at HV tower with mobile phone base station
L. GRCEV (*Macedonia*) and A.P.J. van Deursen (*The Netherlands*). (paper 57)

Mobile phone base stations are often mounted on towers of power transmission lines. The paper presents results from a computer simulation for frequency and time domain distributions. Of special interest are partial lightning currents in the cable shields.

5a.2 Characterisation of tower base earthing systems under impulse conditions
N. HARID et al. (*United Kingdom*). (paper 179)

The authors describe an experimental set-up to inject impulse currents (1.5 and 2.8 kA) into a tower base earthing system. The return ring electrode consists of eight 16 mm diameter copper vertical rods driven to a depth of 2.4 m, connected to each other. The results show a decrease in the impulse resistance with the increase of the applied peak current (thermal conduction effects or soil ionisation). A circuit model based on a lumped-parameter approach, used to simulate the measurement set-up, reproduces the measured waveshapes.

5a.3 Simplified expressions for tower surge impedance based on application of a field-circuit modeling approach
A. SOARES Jr. and S. Visacro (*Brazil*). (paper 152)

The surge impedance of a tower, considered as a lossless vertical transmission line, is analysed through two approaches: a cone and a cylinder. The model geometrical parameters are determined from the actual tower parameters. From the Hybrid Electromagnetic Model, the electromagnetic response of the tower and the resultant electromagnetic transient are computed. An equivalent tower surge impedance is derived and a new expression of the surge impedance is proposed.

5a.4 An EMTP model for grounding impedance of overhead transmission lines. Sensitivity analysis
J.A. MARTINEZ-VELASCO (*Spain*). (paper 149)

How to determine the flashover rate of transmission lines! The ground impedance has a great influence. The paper takes the soil ionisation into account. The statistical computaion uses the Monte Carlo technique.

5a.5 Measurement of lightning surge chracteristics of footing impedance on actual 500 kV transmission towers
K. NONAKA et al. (*Japan*) (paper 132)

Four experimental cases were carried out : steady-state, transient, frequential and mutual coupling impedance between the four tower feet. Most of the measured footing impedances experience a capacitive behaviour and the surge responses are approximately 80 to 90 % of the steady-state value.

5a.6 Method of GSM broadcasting station grounding system analysis. Measurements and calculations
J. WIATER (*Poland*) (paper 43)

The paper provides a method to verify a grounding system configuration. Measured profiles are compared with computed ones.

SESSION 5b

Earthing systems and grounding models

5b.1 A didactic general approach of grounding behaviour for lightning currents
S. VISACRO (*Brazil*) (paper 206)

This is a lesson on the fundamental concepts of grounding, very useful in the understanding of the lightning protection problems.

5b.2 Lightning impulse effective area of earthing grid
R. ZENG et al. (*China*) (paper 78)

The earthing grid is a distributed network made of elementary units represented by π-circuits. The electrical parameters (capacitance C and conductance G) are time-varying. The effect of the soil ionisation is also taken into account.

5b.3 Experimental and analytical study on electromagnetic transient response of a buried bare wire and ground net
H. MOTOYAMA (*Japan*) (paper 186)

The proposed model is based on Sunde's theoretical formulas and includes the frequential behaviour of buried bare wires. The computed results agree with the experimental ones.

5b.4 Practical high frequency measurement of a lightning earthing system
A. ROUSSEAU and P. Gruet (*France*) (paper 141)

Bad experiences are related when confusing a high-frequencey earth impedance with a simple earth resistance. Experimental results (with a high-frequency earth impedance-meter) on six different sites are presented. An equivalent high-frequency resistance R_{HF} is defined and limitations based on experiments are proposed.

5b.5 Impulse and high-frequency tests of lightning earthing
S. WOTJAS (*Poland*) and A. Rousseau (*France*) (paper 240)

Low-frequencey, high-frequency and impulse methods using line models are introduced to compute the earthing impedance and compare with the experimental results. The value of the earthing impedance measured with the impulse meter agrees both with the computational simulation and the frequency-domain measurements.

5b.6 A non-uniform transmission line approach for transient analysis of grounding system under lightning impulse
Y. LIU et al. (*Sweden*) (paper 147)

The field structure of finite-length ground conductors is not TEM. The per unit length parameters (l, c, g) should include the conductor length. The proposed model takes into account the space and time varying coupling between different parts of the grounding conductor. The per unit parameters then become space- and time-dependent.

SESSION 5c

Down conductors and soil resistivity

5c.1 Controlling separation distances with insulated down conductors
O. BEIERL et al. (*Germany*) (paper 56)

How to avoid uncontrolled side flashes! The structure of an insulated conductor is described. The basic idea consists on a semi-conductive coating which prevents against creeping discharges.

5c.2 Evaluation of stress parameters of lightning current arresters in case of subsequent strokes under consideration of travelling wave models for down conductors and earthing
J. MEPPELINK (*Germany*) (paper 125)

A model was developped to study the main stress parameters of arresters in a building. Down conductors are modelised as 5 m long segments of transmission lines with a constant value of the impedance depending on the height of the segment with respect to the ground level. The earthing is represented as a lattice circuit. A model for the lightning current arresters is also developped for very fast transients (ns range). The di/dt and du/dt parameters of subsequent strokes are large compared with the first stroke ones.

5c.3 Which resistivity? The relationship of ground potential rise to soil resistivity in conditions of variable resistivity
C. MILES (*United Kingdom*) (paper 8-9)

A hemispheric model is used with multiple soil resistivities to study the ground potential rise when a lightning strike occurs or when a power fault current arises. The resistivity measurements collected through English weather conditions over years are very interesting. Considerable seasonal and annual variations of resistances are recorded.

5c.4 Influences of low-resistivity materials on lightning impulse properties of grounding devices
Y. TU et al (*China*) (paper 76)

The low-resistivity materials (LRM) such as bentonite are used to decrease the power frequency grounding resistance especially in high soil resistivity regions. The authors carried out experiments with a scale factor of 52. The effect of LRM to decrease the impulse grounding resistance value is obvious. The higher the soil resistivity, the larger is this effect.

5c.5 Modelling of soil electromagnetic behaviour in frequency domain
J.B. GERTRUDES et al. (*Brazil*) (paper 128)

The modelling of the electromagnetic soil behaviour in the frequency domain is essential for fast transients such as lightning currents. In order to analyse the frequency behaviour of the soil conductivity (σ) and permittivity (ε), measurements were made on 1.2 m x 0.2 m x 0.2 m samples. The frequency dependency of the conductivity can be described with a typical function: $W = K_0 + (K_1 + j\,K_2)\ \omega^{\alpha}$.

5c.6 Analysis of soil refiel influence on lightning incidence and current amplitude in Minas Gerais State, Brazil
R.N. DIAS et al. (*Brazil*) (paper 90)

To perform this analysis, 32 towers were selected. The lightning stroke density was evaluated on three areas determined by different radii ($R < 600$ m, $600\text{ m} < R < 1$ km, $1\text{ km} < R$ 10 km). A positive correlation was deduced for the ratio of stroke density and difference of altitudes of adjacent regions.

SESSION 5p : POSTERS

5p.1 Evaluation of touch and step voltages distributions at vicinity of grounding systems using a frequency domain methodology
J.C.S. FILHO and C. Portela (*Brazil*) (paper 23)

Two typical grounding systems are analysed: 1) five 3 m long vertical rods; 2) a grid mesh (100 m x 100 m with subdivisions 16.6 m x 16.6 m). With a linear model describing the soil, touch and step voltages are calulated and discussed.

5p.2 An analytical evaluation of ground current distribution due to lightning strike
G. PAVKOV et al. (*Serbia*, *Montenegro*) (paper 21)

To determine the lightning current distribution into ground, the authors propose to use the Helmholtz equation in the frequency domain.

5p.3 Initial design of a system to determine the behaviour of an earth electrode subjected to real lightning discharges
K.J. NIXON and I.R. Jandrell (*South-Africa*) (paper 167)

A measurement system (Rogowski coil for the current, voltage measurements on strategic points around the test site to avoid inductive coupling due to the wire loop) is proposed to study the earth electrodes performance under lightning transients.

5p.4 Interconnection of different earthing systems of a given installation
C. GOMES (*Sri Lanka*) (paper 75)

Problems (damages increase) arise when connecting the LPS earth to the power earth. A survey was made on 52 Sri Lankan installations. They recommend a 2 ohm maximum value of the DC resistance when interconnecting both earthing systems.

5p.5 Theoretical and experimental study of a grounding grid in high frequency (up to 1 MHz)
J. MONTANA et al. (*Colombia*) (paper 107)

Methods based on the electromagnetic theory show better results than methods based on the transmission line theory. Examples of horizontal conductors and grounding grids are reported and the results are compared with those found in the scientific literature.

5p.6 Frequency dependence of grounding impedances in lightning protection system
B.-H. LEE et al. (*Korea*) (paper 102)

The method of „fall of potential" is modified to avoid inductive coupling between the potential probe and the return current wire at high frequencies when the frequency dependency of the grounding grids become significant. The impedance rapidly increases at frequencies higher than 70 kHz. Measured data are compared with an equivalent circuit consisting of resistive and reactive components.

5p.7 Electromagnetic field radiation due to energized conductors buried in multi-layer soils
S.A MOSADDEGHI et al. (*Iran*) (paper 61)

There are four techniques to study the grouding systems performances: engineering techniques, network theory approaches, transmission line models, electromagnetic models. The paper introduces an electromagnetic field model to study the frequency performance of a grounding system buried into a multi-layer soil.

5p.8 Models of grounding systems under lightning discharges. Simple electrodes configurations
J. RAMIREZ et al. (*Venezuela* and *Spain*) (paper 26)

A RLC π-sections model is developped from the transmission line technique to study the grounding electrodes behaviour. Parameters are calculated using the Finite Element Method. Two electrode configurations are modelised: horizontal electrodes of length l and counterpoise with arms of length l. The simulated transient response of the grounding electrodes show a strong dependency with the soil resistivity and the ground electrode length.