UNIVERSITI PUTRA MALAYSIA

IMPROVED ALGORITHM FOR EVALUATION OF LIGHTNING INDUCED OVERVOLTAGE ON DISTRIBUTION LINES

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IMPROVED ALGORITHM FOR EVALUATION OF LIGHTNING INDUCED OVERVOLTAGE ON DISTRIBUTION LINES

By

MAHDI IZADI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia
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February 2010

Chairman : Mohd. Zainal Abidin Ab Kadir, PhD

Faculty : Engineering

Lighting is a natural phenomenon and can affect the performance of the power lines in two different ways, i.e. direct and indirect strikes. In case of direct strike, it occurs when the tower or shield wire is struck by the lightning and creates an induced overvoltage on phase conductors or shielding wire. Whilst for indirect strikes, it could happen if a lightning strike near the power lines and it produces electric and magnetic fields which depend on a number of factors such as lightning return stroke current and lightning parameters, the distance from power lines and conductivity of the ground. Induced overvoltage is a major cause of interruption on distribution networks and specific research is needed in evaluating the amount of overvoltage induced on such network accurately without many assumptions involved.

This thesis presents the work in estimating the lightning induced overvoltage on distribution lines. Overall, many improvements have been made especially in calculating the electric and magnetic field by revising the integral limits in dipole equations and by considering the different effect of ground conductivities. Additionally, various coupling methods to evaluate the lightning induced voltage have been proposed before reaching the final step of the algorithm which is the estimation of lightning induced overvoltage on the multi-conductors distribution line. The results obtained were then compared with the measurement values recorded during rocket-triggered lightning and other published data.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Sarjana Sains

ALGORITMA DIPERBAIKI UNTUK PENILAIAN VOLTAN LEBIHAN TERARUH KILAT KE ATAS TALIAN PEMBAHAGIAN

By

MAHDI IZADI

February 2010

Pengerusi : Mohd. Zainal Abidin Ab Kadir, PhD

Fakulti : Kejuruteraan

Kilat adalah satu fenomena semulajadi dan boleh mengganggu prestasi talian kuasa dalam dua cara, iaitu langsung dan tak langsung. Bagi kes panahan langsung, ia terjadi bila menara atau kabel pelindung di panah kilat dan menyebabkan voltan lebihan pada konduktor fasa atau kabel pelindung. Sementara bagi panahan tak langsung, ia boleh terjadi sekiranya kilat memanah berdekatan dengan talian kuasa dan menghasilkan medan elektrik dan magnet yang mana bergantung kepada beberapa faktor seperti arus panahan balik kilat dan parameter kilat yang lain, jarak dari talian kuasa dan kekonduksian bumi. Voltan lebihan teraruh merupakan penyebab besar bagi gangguan ke atas rangkaian pembahagian dan banyak penyelidikan diperlukan dalam menilai

jumlah voltan lebihan teraruh pada rangkaian tersebut dengan tepat tanpa banyak melibatkan andaian-andaian.

Tesis ini mempersembahkan kerja-kerja yang telah dijalankan di dalam menganggarkan voltan lebihan teraruh kilat pada talian pembahagian. Keseluruhannya, banyak penambahbaikan telah dilakukan ke atas algortma terutamanya di dalam pemgiraan medan elektrik dan magnet dengan menyemak semula had-had kamiran bagi persamaan dwi-kutub dan dengan mengambil kira kesan yang berbeza bagi kekonduksian bumi. Sebagai tambahan, pelbagai kaedah gandingan untuk menilai voltan teraruh kilat telah dicadangkan sebelum menghampiri kepada langkah terakhir bagi algoritma tersebut iaitu penganggaran voltan lebihan teraruh kilat ke atas konduktor-berbilang (*multi-conductors*) talian pembahagian. Keputusan-keputusan yang dihasilkan kemudiannya dibandingkan dengan nilai-nilai pengukuran yang direkodkan semasa experiment kilat terpicu-roket (*rocket-triggered*) dan data-data lain yang telah diterbitkan.

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APPROVAL

I certify that an examination committee met on month/date/year to conduct the final examination of Mahdi Izadi on his Master of Science thesis entitled "Improved Algorithm for Evaluation of Lightning Induced Overvoltage on Distribution Lines" in accordance with University Putra Malaysia (higher degree) act 1980 and University Pertanian Malaysia (higher degree) regulations 1981. The committee recommends that the candidate be awarded the relevant degree.

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This thesis submitted to the Senate of University Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at UPM or at any other institutions.

MAHDI IZADI

Date: 19 Feb 2010

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