UNIVERSITI PUTRA MALAYSIA

INFLUENCE OF FLOATING ELECTRODE IN GAP BREAKDOWN WITH SPECIAL ATTENTION TO LIGHTNING SIDE FLASHES

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INFLUENCE OF FLOATING ELECTRODE IN GAP BREAKDOWN WITH SPECIAL ATTENTION TO LIGHTNING SIDE FLASHES

By

GHASEM NOURIRAD

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

January 2014

Dedicated to my parents, beloved brothers and sisters

Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of Master of Science

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Chairman: Chandima Gomes, Professor
Faculty: Engineering

The influence of the presence of metallic parts on the body on the probability of lightning strikes to a human being is a long debated phenomenon without any concrete conclusions. There are many reported lightning incidents in publications and news in which victim stood nearby a place that has been struck by lightning. The two schools of thoughts that argue on both sides of the phenomenon mostly concentrate on direct lightning strikes. The percentage of side flashing injuries is four times more than that of direct strike. Some real events of lightning incidents have been reported in the dissertation in which there was a metallic object in vicinity that acted as a floating object. Consequently, the minimum separation between a human without having a floating electrode and an object which has been struck by lightning has been simulated and compared with the previous values. Then, the influence of the floating electrode carrying on the body or nearby is studied. An experimental set-up has been done in UPM, UTM and TNBR to conduct the study. A rod-rod gap of 30 cm length has been implemented. Some different floating electrodes have been located between the two rods. Positive impulse is applied to one rod and the other rod is grounded. The test has been done for some specific positions of the floating electrodes to find out the influence of the floating electrode position. In each test, 25 shots have been attempted in the up and down procedure.Statistical analysis has been done using SPSS software to find the statistical significant differences of comparing two or more groups of obtained experimental data. Several modules have been used due to different tasks. The modules that have been used are Paired t-test, Independent t-test and Non-parametric test. The experimental results that are presented in this thesis show that there is a statistically significant influence of floating electrodes on rod-rod air gap breakdown when the floating electrode is close to either of the electrodes. The results may be extrapolated to explain the influence of electrical floating metal parts in lightning side flashes, where the arcing distances are a matter of only few meters. The theoretical results of calculation of minimum separation between a human and different objects stuck by lightning show that, the minimum separation depends on several parameters such as object impedance and lightning current parameters. In addition, the experimental outcomes are still inconclusive with regard to direct lightning strikes where the final jump may be few hundreds of meters. Based on our results we recommend the removal of metal parts from the body, if such action is possible, in the event of thunderstorms, especially when the person is within the proximity of potential objects for lightning strikes.

Abstak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

PENGARUH ELEKTROD TERAPUNG KE ATAS FENOMENA PECAHAN ELEKTRIK CELAH UDARA DENGAN PERHATIAN KHUSUS PADA ISU KILAT TIDAK LANGSUNG

Oleh

GHASEM NOURIRAD

Januari 2014

Pengerusi: **Chandima Gomes, Professor**
Fakulti: **Kejuruteraan**

Pengaruh kewujudan objek-objek logam pada badan manusia ke atas kebarangkalian sambaran kilat adalah suatu isu yang telah lama diperdebatkan tetapi masih tidak berkesudahan secara jelasnya. Berdasarkan kajian literatur, terdapat banyak insiden manusia yang berdiri berhampiran objek atau kawasan yang disambar kilat turut disambar kilat. Terdapat dua sudut pandangan pada fenomena tersebut dan ianya tertumpu pada sambaran kilat langsung. Walaubagaimanapun, risiko kecederaan sambaran kilat tidak langsung adalah empat kali ganda risiko sambaran kilat langsung. Turut dilaporkan di tesis terdahulu bahawa terdapat logam yang bertindak sebagai objek terapung dalam sesetengah insiden kilat. Dalam tesis ini, impak kewujudan konduktor terapung pada risiko sambaran kilat pada objek berhampiran objek yang disambar langsung akan dikaji.
Beberapa eksperimen telah dilakukan di UPM, UTM dan TNBR. Celah 30cm bagi konfigurasi rod ke rod telah diaplikasikan. Konduktor terapung dalam beberapa bentuk yang berlainan telah digantungkan di antara dua rod. Impuls positif telah dihantar ke satu rod manakala rod yang kedua dibumikan. Ujikaji tersebut dilakukan dengan menggantung setiap konduktor terapung pada beberapa posisi yang spesifik untuk mengkaji kesan kedudukan atau lokasi konduktor terapung. 25 tembakan telah di lepaskan dalam setiap ujikaji tersebut mengikut prosedur “up and down”. Analisis statistic dengan perisian SPSS telah diimplementasikan untuk mengenalpasti samada terdapat perbezaan signifikan antara dua atau lebih kumpulan data eksperimen. Beberapa modul telah digunakan iaitu Paired t-test, Independent t-test dan Non-parametric test. Keputusan eksperimen yang akan dibentangkan di tesis ini menunjukkan bahawa wujudnya kesan yang signifikan apabila konduktor terapung berada berhampiran kedua-dua rod. Keputusan tersebut boleh dilanjutkan untuk menjelaskan kesan kewujudan konduktor logam terapung dalam insiden kilat tidak langsung di mana jarak pengarkaan adalah tidak begitu panjang.

Keputusan eksperimen masih tidak mampu memberi konklusi yang ketara berhubung insiden kilat langsung di mana lonjatan terakhir kilat adalah ratusan meter. Berdasarkan keputusan kajian, kami menyarankan supaya dalam kejadian kilat petir, manusia perlu menyingkirkan objek-objek bersifat logam terutamanya apabila berada berhampiran objek yang berpotensi disambar kilat.

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I certify that a Thesis Examination Committee has met on 28.01.2014 to conduct the final examination of Ghasem Nourirad on his thesis entitled "Influence of Floating Electrode in Gap Breakdown with Special Attention to Lightning Side Flashes" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to senate of Universiti Putra Malaysia and has been accepted as fulfilment of requirement for degree of Master of Science. Members of the Supervisory Committee were follows:

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DECLARATION

Declaration by graduate student

I hereby confirm that:

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