



UNIVERSITI PUTRA MALAYSIA

**MODELING OF 132 KV SUBSTATION FOR INSULATION
COORDINATION**

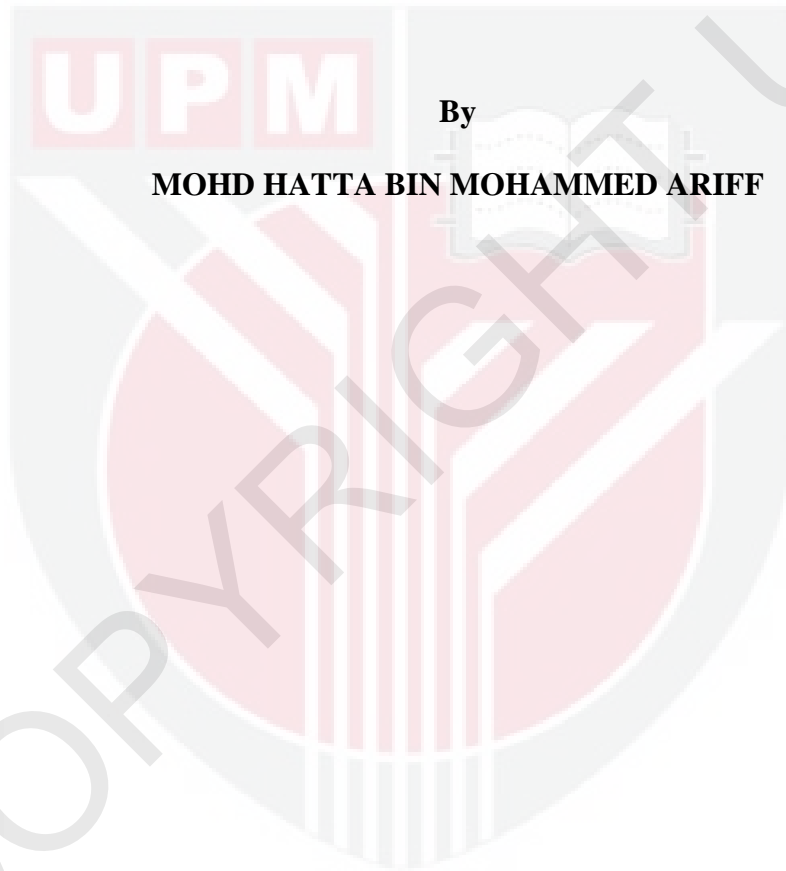
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**MODELING OF 132 KV SUBSTATION FOR INSULATION
COORDINATION**

By

MOHD HATTA BIN MOHAMMED ARIFF



**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Master of Science**

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MODELING OF 132 kV SUBSTATION FOR INSULATION COORDINATION

By

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January 2010

Chairman: Dr. Mohd Zainal Abidin bin Ab. Kadir

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Substation is an essential part of the grid systems which often regarded as the most expensive component in the power systems. In general, insulation coordination studies are an important and are used to determine the reliability of the substation. In most blueprints, the default design of a substation always being designed to have an absolute protections where all the possible stresses had already put into account according to the applied standard which sometimes being overprotected and expensive. The intention of this work is to model an existing substation in the way to investigate its design capability to withstand the excessive transient overvoltage (i.e. lightning surge), in an attempt to have a more cost effective design model. The selected substation model is adopted from a 132 kV Simpang Renggam-Ayer Hitam substation. The substation is modeled using PSCAD/EMTDC software and the substation drawing details has been courteousness provided by the Tenaga Nasional Berhad (TNB). Throughout the model, several issues have been addressed and carried out in this study regarding the optimization of the substation design. Issues such as arrester placement strategies, determination of transformer breakdown current, arrester placement distance, as well as the energy handling capability for the

arrester have been investigated. The findings unveil that; proper placement of arrester is crucially needed in order to optimize the substation performance in term of its reliability and cost effective. Besides that, the determination of current level associated to the breakdown of the transformer, could help the engineers to estimate the capability of the protection scheme in a way to improve the design. Moreover, the development of energy within the arrester which could cause the reduction of protection scheme potential is not only due to the magnitude of the stress current, but also influenced by other factors such as stress waveform durations and the geographical location of the substation. Finally, the highlight of this work is basically through the development of the substation model via PSCAD. It has become an alternative option for researchers to conduct various investigations in subject to substation design improvement and insulation coordination studies.

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

**MEMODEL PENCAWANG UTAMA 132 kV UNTUK KAJIAN
KOORDINASI PENEBATAN**

Oleh

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Pencawang utama merupakan satu bahagian penting dalam sistem grid di mana ianya dianggap sebagai komponen yang termahal dalam sistem kuasa. Secara amnya, kajian koordinasi penebatan adalah penting dan ianya digunakan untuk menentukan prestasi kebolehppercayaan bagi sesebuah pencawang utama. Dalam kebanyakan pelan rangka tindak, rekaan asal bagi pencawang biasanya direka supaya mempunyai perlindungan yang mutlak di mana semua kemungkinan bagi berlakunya tegasan telah diambil kira berdasarkan piawai yang diterimapakai yang mana kadangkala ianya memberikan perlindungan yang terlampau dan mahal dari segi kos pembinaannya. Tujuan kajian ini adalah untuk memodel semula pencawang utama yang sedia ada bagi mengkaji kemampuan rekaan asal untuk menangani voltan lampau fana seperti pusuan kilat yang berlebihan dalam usaha untuk menghasilkan satu model rekaan yang lebih berkesan dari segi kos. Model pencawang utama yang dipilih telah diambil dari pencawang utama 132 kV yang menghubungkan antara Simpang Renggam-Ayer Hitam. Pencawang utama ini telah dimodel semula dengan menggunakan perisian PSCAD/EMTDC dan maklumat perincian bagi pelan rekaan

telah disumbangkan oleh ehsan dari Tenaga Nasional Berhad (TNB). Menerusi model tersebut, beberapa isu telah disenaraikan dan dibawa bersama kajian yang berkaitan dengan mengoptimumkan rekaan pencawang utama. Isu-isu seperti strategi menentukan kedudukan penangkap pusuan, penentuan tahap arus yang merujuk kepada sebelum terjadinya kerosakan pada pengubah, jarak kedudukan penangkap pusuan dan juga keupayaan penangkap pusuan mengendali tenaga yang terjana di dalamnya telah dikaji. Keputusan dari kajian mendapati bahawa strategi meletakkan penangkap pusuan yang kedudukan sesuai adalah penting bagi mengoptimumkan tahap prestasi pencawang utama dari segi kebolehpercayaan dan kos keberkesannya. Selain itu, menentukan tahap arus yang merujuk kepada sebelum terjadinya kerosakan pada pengubah juga boleh membantu jurutera untuk menganggar kebolehan skema perlindungan dalam usaha memantapkan lagi sesebuah rekaan. Tambahan lagi, tenaga berlebihan yang terhasil di dalam penangkap pusuan dimana ianya boleh merendahkan potensi skema perlindungan, bukan hanya disebabkan oleh tahap arus tegasan yang tinggi, tetapi ianya juga dipengaruhi oleh faktor-faktor seperti tempoh gelombang tegasan dan lokasi geografik bagi pencawang utama tersebut. Akhir sekali, sumbangan terpenting dalam kajian ini adalah menerusi penghasilan model pencawang utama dengan menggunakan PSCAD. Ianya menjadi pilihan alternatif bagi pengkaji untuk menjalankan kajian-kajian lain dalam usaha memantapkan rekaan pencawang utama dan juga kajian koordinasi penebatan.

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APPROVAL

I certify that a Thesis Examination Committee has met on 27 January 2010 to conduct the final examination of Mohd Hatta bin Mohammed Ariff on his thesis entitled “Modeling of 132 kV Substation for Insulation Coordination” in accordance with Universities Colleges Act 1971 and 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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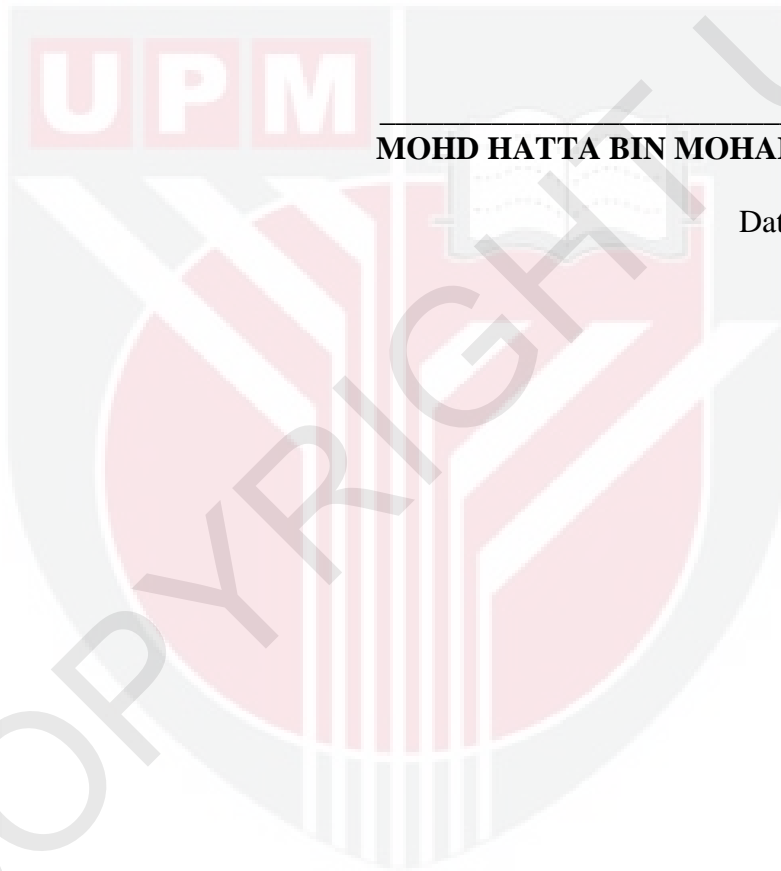
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DECLARATION

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



MOHD HATTA BIN MOHAMMED ARIFF

Date: January 2010



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