EVALUATION OF SURGE ARRESTER REQUIREMENT FOR OVERHEAD TRASNMISSION LINE IN BACKFLASHOVER ANALYSIS.

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Bekp
2010

" I hereby declare that I have read through this report entitle "title of the project" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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Date : 10 May 2010

EVALUATION OF SURGE ARRESTER REQUIREMENT FOR OVERHEAD TRASNMISSION LINE IN BACKFLASHOVER ANALYSIS.

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A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Industrial Power)

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2009

I declare that this report entitle "*Evaluation of Surge Arrester Requirement for Overhead Transmission Line in Backflashover Analysis*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is no concurrently submitted in candidature of any other degree.

Signature : ....

Name : Jeremy Ong Chun Chian

Date : 10/05/10

To My Beloved Mother and Father

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ABSTRACT

Lightning strike is the major factor that leads to overvoltage and equipment failure in electrical power system. Thus, insulation coordination is an essential part of power system studies and was used to determine the performance of a transmission line or substation. This project generalizes the modelling of 132kV transmission line design for the purpose of backflashover simulation using the power system simulation tools that is Power System Computer Aided Design (PSCAD) software. Sample of transmission line data was taken from Tenaga National Berhad (TNB) for the purpose of simulation using PSCAD software .Crucial part of the studies include the model of transmission line components such as insulator coordination, tower model, tower footing model and surge arrester. This research will focus on the effect of different position of transmission line surge arrester placement at transmission line to the value of backflashover rate. A model of surge arrester is implemented in PSCAD simulation across the line insulation, to prevent flashover. The capabilities of arrester are investigated so that the proper arrester rating can be selected for any system requirement. In addition, extensive analysis on the placement of surge arrester at the substation and the prediction of probability of transformer damage are also presented. Results were analyzed and the influence of transmission line surge arrester placement to backflashover rate at transmission line and the probability of transformer damage at substation were discussed. The results will be discussed based on literature review and previous findings obtained by other researchers. Findings from this project can be a significant modelling guideline to the transmission line designers or other researchers to improve the performance of overhead transmission line in term of backflashover rate and probability of transformer damage at substation.

ABSTRAK

Kilat merupakan faktor utama yang menyebabkan voltan lampau dan kegagalan pada sistem kuasa elektrik. Oleh itu, koordinasi penebatan memainkan peranan yang penting dalam kajian sistem kuasa dan digunakan untuk menentukan pencapaian sistem rangkaian talian penghantaran atau pencawang. Projek ini mengetengahkan model talian penghantaran yang dibentuk menggunakan sejenis simulasi alat sistem kuasa simulasi iaitu perisian Power System Computer Aided Design (PSCAD) bertujuan untuk melaksanakan simulasi pemecikan api. Sampel maklumat sistem talian penghantaran diambil daripada Tenaga Nasional Berhad (TNB) dengan tujuan simulasi menggunakan perisian PSCAD. Bahagian terpencil dalam kajian ini adalah membentuk komponen talian penghantaran yang terdiri daripada koordinasi penebatan, model menara, rintangan tapak menara dan penangkap pusuan kilat. Penyelidikan ini fokus kepada kesan penyambungan penangkap pusuan kilat ditempatkan pada sistem talian penghantaran. Model penangkap pusuan ditempatkan dalam simulasi PSCAD dengan talian penebat, untuk mencegah pemercikan api. Pemilihan penangkap pusuan yang sesuai sepadan dengan kadar alatan sistem akan disiasat dalam projek ini. Kajian mengenai pengaruh penempatan penangkap pusuan dalam sistem talian penghantaran terhadap kadar pemercikan api dan kadar kerosakan alat pengubah-ubah di pencawang akan dibincangkan dalam projek ini. Hasil kajian dalam projek ini boleh diggunakan sebagai contoh model bagi para pereka sistem talian penghantaran bertujuan untuk meningkatkan keupayaan sistem talian penghantaran kuasa tinggi.

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LIST OF ABBREVIATIONS

ac	-	Alternating Current
ACSR	-	Aluminum Conductor Steel Reinforced
SF	-	Shielding Failure
BF	-	Backflashover
BFR	-	Backflashover Rate
BIL	-	Basic Lightning Insulation Level
CB	-	Circuit Breaker
CFO	-	Critical Flashover
LIPL	-	Lightning Impulse Protective level
SIPL	-	Switching Impulse Protective level
PSCAD	-	Power system computer Aided Design software
ATP	-	Alternative Transient Program
EMTP	-	Electro Magnetic Transient Program
IEE	-	The Institution of Electrical Engineers
IEEE	-	Institute of Electrical and Electronic Engineers
SA	-	Surge Arresters
MOSA	-	Metal Oxide Surge Arresters
SiC	-	Silicon Carbide
S/S	-	Substation
TFR	-	Tower Footing Resistance
TLA	-	Transmission Line Arresters
TNB	-	Tenaga Nasional Berhad
ZnO	-	Zinc Oxide
HV	-	High Voltage
EHV	-	High voltage transmission line
IVFO	-	Induced Voltage Flashover

LIST OF SYMBOLS

μF	-	micro-Farad
μH	-	micro-Hendry
μs	-	nicro-second
A	-	Ampere
C	-	Capacitive
Ng	-	Ground Flash Density per Kilometer2 per year
kA	-	kilo-Ampere
kJ	-	kilo-Joule
kV	-	kilo-Volt
L	-	Inductive
MV	-	Mega-Volt
R	-	Resistance
Uc	-	Maximum Continuous Operating Voltage
Ur	-	Rated Surge Arrester Voltage
Km	-	kilometer
V	-	Volt
Z	-	Impedance
Zt	-	Surge Impedance

CHAPTER 1

INTRODUCTION

1.1 Project Background

In Malaysia, Tenaga National Berhad (TNB) transmission lines consists of more than 420 transmission network in Peninsular are linked together by approximately 11,000 km of transmission line operating at 132, 275, 500 kV [1]. This project is based on the 132kV MPSS-MCCA transmission line (Pahlawan Substation-Malacca substation).

Lightning is a natural phenomenon, where typically 90% of cloud-to-ground flashes transfer negative charge. Such a flash consists of a sequence of one or more high amplitude, short duration current impulses or strokes, the subsequent strokes are sometimes called re-strokes [2]. The phenomenon of backflashover occurs when lightning strikes at the top of the tower or shield wire and cause flashover from the tower to the phase conductor.

1.2 Problem Statements

There are several problem cause by lightning stroke to the overhead transmission line due to overvoltage. Lightning can cause permanent damage to electrical equipment include flashover of insulation inside motors or transformers, so that the equipment is no longer functional [3]. The different placement of transmission line surge arrester can effect the backflashover rate of the transmission line. For substation, lightning can cause backflashover and induced overvoltages generate surge voltage that can causes damage to the substation equipment as shown in Figure 1.1.

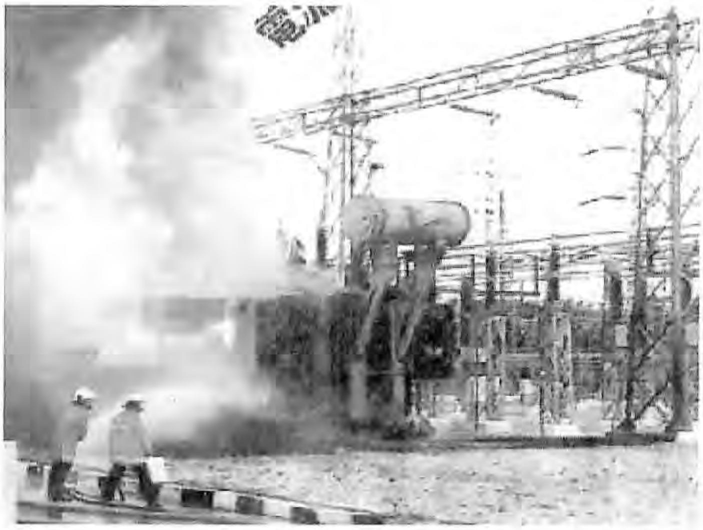

Figure 1.1 Damage to the transformer at TNB substation

Therefore, it is very important to study the application of surge arrester to improve the performance of overhead transmission line. The influences of different placement of transmission line surge arrester in transmission line are studies to reduce the BFR.

The purpose of this project is to optimize the performance of transmission line and substation using PSCAD simulation programs.

1.3 Project Objectives

Objectives of this project are:-

(i) To develop the model of overhead transmission line using PSCAD.

(ii) To develop transmission line surge arrester model using PSCAD.

(iii) To investigate effect of different placement of TLSA at transmission line to the values of BFR.

(iv) To estimate the probability of transformer damage with respect to different TLSA placement at substation.

1.4 Scope of works

This project only involved

- The modelling of 132kV MPSS-MCCA transmission line which includes modelling of overhead transmission tower, tower footing, insulator, first stroke lightning current and surge arrester model.
- To evaluate lightning performance of transmission line backflashover rate (BFR) and the shielding failure rate should be consider.
- This project only concern on bakflashover rate because direct strokes to the phase conductors due to shielding failures are relatively less likely to occur [4].
- The model of the transmission line is applied theoretically in term of method used in simulation tool such as PSCAD and MATLAB software.

1.5 Thesis Outlines

This research project is divided into six chapters. Generally, some basic principals, theories, equations, previous researches references, simulation result, comparison of result and discussion were included in these six chapters based on the contents requirements of each chapter.

Chapter 1 includes the project background, project objective, problem statement, scope of work and thesis outlines. Chapter 2 presents literature information of research project such as insulation coordination, lightning incidence to transmission line and overhead transmission line. This chapter briefly explains the characteristics of the insulation coordination as a protective device. Moreover, this chapter also explains the phenomenology of lightning incidence that terminate on transmission line and on substation. Modelling guidelines of overhead transmission line using leader progression model, tower footing model and surge arrester model use for backflashover analysis is discuss.

In chapter 3 presents the methodologies of constructing lightning stroke model, modeling of transmission line and surge arrester model using PSCAD software. The method will be presented in graphs and flow chart of the analyzed simulation result together with a brief explanation.

In chapter 4, simulation setup in response for transmission line surge arrester positioning in backflashover. Investigation the effect of backflashover and the influence of surge arrester presents in transmission line and substation. And the possibility of transformer damage due to lightning strike at the substation.

Chapter 5 will discussed the simulated results of backflashover analysis obtained from PSCAD software. The backflashover rate and probability of transformer damage is calculated and analyzed for each case presented.

Finally, Chapter 6 will conclude all the works and studies that had been presented in the pervious five chapters. Besides, some recommendations as well as the contributions to the project will be mentioned.