LIGHTNING PERFORMANCE STUDY ON EXISTING 275kV OVERHEAD LINE IN TNB SYSTEM

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Dedicated to my lovely wife and children

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ABSTRACT

Lightning is the primary cause of tripping for most overhead power transmission lines. Few methods have been discovered to estimate the lightning performance of a transmission line. However these methods are not properly defined due to the nature of lightning which is difficult to analyze and model. Studies are continually being done to discover alternative methods that can be implemented to improve the lighting performance of transmission lines in addition to the standard methods such as adding Overhead Ground Wires (OHGW), reducing ground resistance, adding counterpoise and increasing insulation. In this project, a case study on lightning performance for an existing 275kV overhead transmission line in TNB system which tripped on numerous occasion due to lightning will be simulated. The lightning performance will be simulated using TFLASH software and result will be analyzed. The influence of parameters such as tower footing resistance, ground flash density and tower lightning arrestor on lightning performance of a selected transmission line will be analyzed and appropriate corrective measures will be discussed as well.

ABSTRAK

Kilat merupakan punca utama berlakunya pelantikan pada kebanyakan talian penghantaran. Walaupun beberapa kaedah telah ditemui untuk menganggarkan prestasi kilat sesuatu talian penghantaran, namun ianya tidak dapat ditakrifkan dengan tepat disebabkan kejadian kilat itu sendiri sukar dianalisa dan dimodelkan. Namun begitu, kajian masih diteruskan untuk menemui kaedah-kaedah yang dapat dilaksanakan untuk mempertingkatkan prestasi kilat talian penghantaran selain daripada kaedah-kaedah standard yang sudah terwujud seperti tambahan OHGW, mengurangakan rintangan tanah, menambah counterpoise serta menambahkan penyalutan. Projek ini membuat satu kajian berkenaan prestasi kilat pada talian penghantaran 275kV yang sedia ada dalam sistem TNB dan sering terpelantik disebabkan kejadian kilat. Kajian prestasi kilat ini akan dilaksanakan menggunakan perisian TFLASH dan keputusannya akan dianalisa. Pengaruh parameter-parameter seperti rintangan kaki menara, kepekatan kilat serta pemasangan penangkap kilat pada menara akan dianalisa dan tindakan pembaikan yang sesuai juga akan dibincangkan.

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TNB	-	Tenaga Nasional Berhad
CTIS	-	Centralised Tripping Information System
OHL	-	Overhead Line
TSI	-	Tower Surge Impedance
TFR	-	Tower Footing Resistance
GFD	-	Ground Flash Density
TLA	-	Tower Lightning Arrestor
OHGW	-	Overhead Ground Wire
CFO	-	Critical Flashover
PLTG	-	Plentong
CBRU	-	Cahaya Bharu
ACSR	-	Aluminum Conductor, Steel Reinforced

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Overhead transmission line is one of the most important parts of a transmission system. Tripping or unscheduled interruption of overhead line (OHL) can cause load loss to customer if the OHL is directly connected to Distribution Transformers or have T-Off connection to other OHL which is connected to Distribution Transformers. As the quality of electricity supply demand from the customer has increased, few minutes of blackout to residential area or voltage dip to semiconductor factory can't be tolerated. Tenaga Nasional Berhad has to strive for high power quality and less interruption to consumers. Initiatives to reduce tripping have to be identified to ensure the customers are happy.

They are many reason or root cause that can contribute to the tripping of a overhead line. However, for most overhead power transmission lines, lightning is the primary cause of unscheduled interruptions. Several methods for estimating lightning-outage rates have been developed in the past, and many publications have been written on how to design transmission lines that experience minimum interruptions.

Since an overhead line is tall and some distance above the surrounding ground, this increases the likelihood of the line being 'struck' by lightning and the line may or may not suffer flashover between phase conductors and some earthed points.

All lightning faults are due to an overstressing of the line insulation. At system voltages above 60kV, lightning faults are due either to a direct lightning stroke to the phase conductor which is commonly referred as a 'shielding failure' or to a voltage rise of the tower steelwork due to a lightning stroke to a tower or to the earth conductor system which is commonly referred as 'back flashover'.

Faults due to shielding failures occur when the product of the lightning stroke current on the phase conductor and the impedance of the conductor system viewed from the stricken point exceed the impulse strength of the phase insulation. Whereas faults due to back flashover occur when the difference in potential between tower steelwork and an adjacent phase conductor exceeds the impulse withstand strength of the phase insulation.

1.2 Problem Statement

Based on Centralized Tripping Information System (CTIS) website in TNB, almost 20-30% of Overhead line tripping (132kV and above) under jurisdiction of Asset maintenance Johor - 1, Transmission TNB is due to lightning strike. Figure 1.1 shows the root cause of overhead lines tripping in TNB system for financial years FY09/10 and FY10/11. [1]

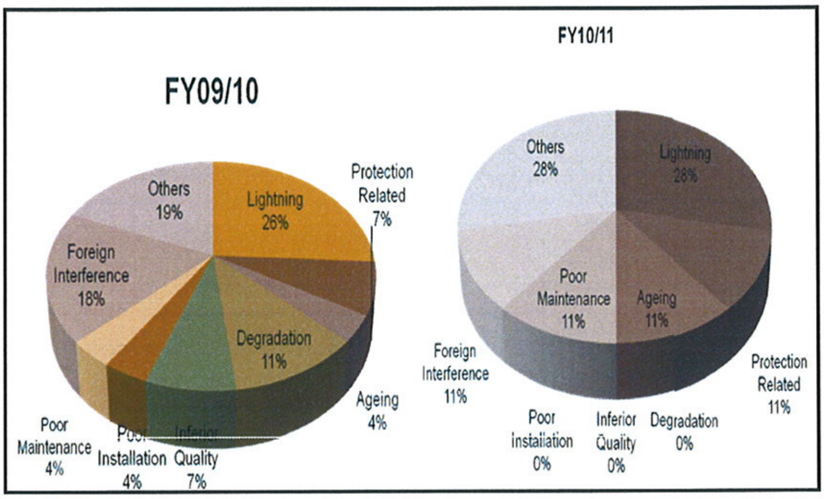

Figure 1.1: Tripping Data of overhead line in TNB [1]

Since 275kV overhead lines forms the backbone of the TNB system grid, any double circuit tripping on 275kV transmission lines due to lightning is not tolerable as it can cause load loss. As the quality of electricity supply demand from the customer has increased, few minutes of blackout to residential area or voltage dip to semiconductor factory can't be tolerated. TNB has to strive for high power quality and less interruption to consumers. Initiatives to reduce tripping have to be identified to ensure the customers are happy.

Therefore, Lightning Performance study on existing 275kV overhead line in TNB system has been chosen as a topic and project for this thesis. Based on CTIS data, one existing 275kV overhead line that had tripped frequently due to lightning will be identified for the purpose of this project. The findings of the study will be used to come up with practical ways to improve the lightning performance of existing 275kV overhead lines in TNB system.

1.3 Objectives

The main objectives of this project are:

i. To model one existing 275kV OHL using TFLASH software.

ii. To carry out lightning performance on 275kV OHL using TFLASH based on few case studies.

iii. To compare the results and findings for each case study by changing the key parameters.

iv. To analyze the influence of Tower Footing Resistance, Ground Flash Density and Tower Lightning Arrestor on lightning performance of 275kV OHL.

v. To identify practical ways to improve lightning performance of existing 275kV OHL in TNB system.

1.4 Scope of Project

To achieve the above said objectives, the scope of this project will focus on 275kV overhead transmission lines under jurisdiction of Asset Maintenance Johor, Transmission Division, TNB. Based on the 5 years tripping statistics of overhead transmission line, one existing transmission line that experienced most number of tripping due to lightning will be selected as part of initial analysis. The lightning performance of this line will be calculated and compared with world standard. Few case studies will conducted on the selected transmission line using TFLASH software to check the influence of several parameters of this line that has direct impact on the lightning performance and propose practical ways to improve it.

1.5 Report Organization

Chapters 1 and 2 will form the beginning part of this project report. In Chapter 1, introduction, problem statement, objectives and scope of this project will be discussed. Chapter 2 is comprises of literature review on some of the key parameters that has influence whether directly or indirectly on lightning performance of a transmission line. Special methods to improve lightning performance and analysis on some of the previous research also discussed in Chapter 2.

Chapters 3 and 4 form the body of the report. Chapter 3 revolves around the research methodology. This Chapter provides information on all the gathered data which are required for the purpose of modeling OHL in TFLASH. Chapter 4 is basically the guidelines on the modeling process using TFLASH software based on the data gathered.

Chapters 5 and 6 form the closing part of this report. Chapter 5 consists of results and discussion of all the five case studies simulated in TFLASH software. Chapter 6 concludes all the findings and suggestions for the future studies.

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