SHORT CIRCUIT CURRENT PROTECTION SCHEME IN 500 kV TRANSMISSION SYSTEM

Mohamad Fahmi Bin Mohamad Noh

Bachelor of Electrical Engineering (Industrial Power)

JUNE 2013

FINAL YEAR PROJECT II

BEKU 4894

SHORT CIRCUIT CURRENT PROTECTION SCHEME IN 500Kv

TRANSMISSION SYSTEM

SEMESTER 2

SESSION 2012/2013

4-BEKP

SECTION 2

PREPARED BY

MOHAMAD FAHMI BIN MOHAMAD NOH

I hereby declare that I have read through this report entitle “short circuit current protection for 500kV in Melaka area network” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power).

Signature :………………….

Name :R.Hery Satrio Soeprapto

Date : ……………………...

SHORT CIRCUIT CURRENT PROTECTION 500 kV TRANSMISSION SYSTEM

MOHAMAD FAHMI BIN MOHAMAD NOH

A report submitted in partial fulfillment of the requirements for the degree

Of Bachelor of Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2013

With lots of love dedicated to my beloved

Mother **(Pn Rosna Binti Ahmad)**

Dad **(Mohamad Noh Bin Bidun.)**

Siblings **(Mohamad Fauzi,Mohamad Fakhri**

,Noor Fadzlina,Noor Fazlin)

For the prayers,support and encouragement.

I was blessed because I was loved by all of you.

Thank you very much.

ACKNOWLEDGEMENT

Firstly, I would like to say thank you to both of my parent for their continous support for me to complete this thesis .Then for Sir Hery Satrio Soeprapto whom is my supervisor because of the guidance and knowledge that she had gave me in the processof working with my project throughout the whole year. Without the continued of supportof him, it will be harder in completing this thesis as I had faced manydifficulties. Their morale support is tremendously appreciable.

Credit also goes Faculty of Electrical Engineering without saying as they are giving the undergraduate their support either in direct or indirectly ways. I like to express my gratitude because of their encouragement throughout my whole years of my studies in Universiti Teknikal Malaysia.

Last but not least, I appreciate the help and contribution of my friends for whom had teach and told me about the knowledge that I need to know during my work on the project. Without all these people's morale support, I would have difficult times in completing this project. Once again, from the deepest of my heart, I sincerely thank all the party that involved.

ABSTRACT

Electricity is well known as the driving force for a country, which is undergo rapid industrialization for the last few decades. Configuring large power supply in high load density networks and interconnections between power grids will cause enormous short-circuit current. A fault current limiter offers a choice in such case. First, this paper attempts to give an overview of fault current clearance equipment for medium and high voltage applications. Based on the 16th edition of IEEE wiring regulation, short circuit current is originated from the term overcurrent which is had been describe as a current that exceed its rated value. The main function of protection is to distinguish fault or failed section in the power distribution system with the suitable safety that will only cause small disruption to the power supply. If the times of the short circuit increase, the damaged it may bring to the system will increase. In medium and high voltage circuit breaker, any failure in protection system will causing instability to the power system to the whole country. It is very important to setup the right equipment in the power protection system. The usage of relay in the power system could discriminate the faulty condition. For extra high voltage system, high speed IDMT relay is used to clear the fault before it damage the system. The relay coordination study also will help to determine the most effective way to clear the faulty condition. 3 type of different relay can be used to distinguish its effectiveness in the distance protection based on its setting. With the help of PowerWorld and Matlab software, the simulation of the 3 relay can be simulate on the power system. Powerworld software can be used to create the 500kV power system and Matlab can be used to determine the appropriate relay setting. The most suitable setting is the one that could operate efficiently with the circuit breaker.

ABSTRAK

Tenaga elektrik sememangnya telah dikenali sebagai tenaga penggerak dalam sesebuah Negara, industri ini telah mengalami perubahan yang sangat besar sejak beberapa dekad yang lalu. Untuk membina bekalan kuasa yang besar dalam jaringan bebanan yang tinggi, jaringan sambungan antara grid kuasa akan menyebabkan berlakunya arus litar pintas yang sangat besar. Kertas kajian ini akan memberikan gambaran tentang keberkesanan peralatan yang sesuai untuk mengendalikan litar pintas. Berdasarkan peraturan IEEE [1] edisi 16 tentang peraturan pendawaian, arus litar pintas adalah berasal daripada istilah lebihan arus yang menggambarkan tentang arus yang telah melebihi nilai tertinggi yang dapat disalurkan oleh sesebuah sistem kuasa. Fungsi utama sistem perlindungan adalah untuk membezakan lebihan arus yang mampu mengganggu kestabilan sistem kuasa. Jika masa untuk membezakan lebihan arus meningkat, kerosakan yang lebih serius akan terjadi kepada sistem kuasa. Dalam penghantaran kuasa sederhana dan tinggi, sebarang kegagalan sistem perlindungan mungkin akan menyebabkan ketidakstabilan kepada keseluruhan sistem di dalam negara. Adalah menjadi kepentingan untuk menyediakan peralatan yang sesuai untuk perlindungan sistem kuasa. Penggunaan geganti berkelajuan tinggi IDMT digunakan untuk membezakan arus lebihan sebelum ianya merosakkan sistem kuasa. Kajian tentang koordinasi geganti juga banyak membantu untuk menentukan cara terbaik untuk menguruskan lebihan arus. 3 jenis geganti boleh digunakan untuk membezakan keupayaan geganti berdasarkan tetapan pada geganti. Dengan bantuan perisian Powerworld dan Matlab, keupayaan geganti boleh disimulasikan dalam sistem kuasa. Perisian Powerworld digunakan untuk membina sistem kuasa dan Matlab digunakan untuk mendapatkan tetapan yang sesuai.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOL

I_1	-	The rms current in the upper electromagnet
I_2	-	The rms current in the lower electromagnet
θ	-	The angle between I_1 and I_2
IDMT	-	Inverse Definite Minimum Time
PS	-	Relay Plug Setting
TSM	-	Time Setting Multiplier
RSI	-	Relay Setting Current
FC	-	Fault Current
PSM	-	Plug Setting Multiplier
RCOT	-	Relay Characteristic Operating Time
ROT	-	Relay Operating Time
DT	-	Discrimination Time
RnOT -	-	Operating Time of Relay Nearest to Fault
RjOT -	-	Operating Time of the Next Adjacent Relay
λ and α-	-	Constant
R	-	Resistance
X	-	Reactance
V_p	-	Transformer Primary Voltage
V_s	-	Transformer Secondary Voltage

P	-	Real Power
Q	-	Reactive Power
S	-	Apparent Power
CT	-	Current Transformer
V	-	Voltage
SI	-	Standard Inverse
VI	-	Very Inverse
EI	-	Extremely Inverse

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The importances of system protection in power system growth simultaneously with the growth of electrical technology. Since alternating current discovered by Thomas Edison, many experiments to improve the overall system in order provide efficiency and safety to the electricity customer. With the growth of power technology, problems with the fault in the system, voltage regulation had been overcome phase by phase. One of the main problem in the power grid is short circuit protection, eventhough many research had been done to avoid from this fault, the protection failure is still happen. Short circuit may cause a large delivering amount of energy in a short time, rapid thermal increase, wire breakdown and even explosion.

In Malaysia, the main electricity supplier, Tenaga Nasional Berhad (TNB) had specify the short circuit current rating for their customer. In their books, Electrical Supply Application Handbook(ESAH) said that the rating for 500kV transmission is 50kA and break time is 1s. All of the equipment that connected to the TNB must follow this short circuit current rating based on their load supply. In this country, 500kV transmission line cover total area 522km. This project started in Bukit Tarek to Kapar transmission line.

Then it is extended to Manjung power station through Air Tawar. The last phase of this 500kV transmission line is in 2006, it is installed to carry power generated from Tanjung Bin power station and connected to Bukit Batu. As the extra high voltage system is still in the third phase of its construction level, the system must be provided with the adequate protection to ensure it can sustain the future operation without interrupting the existing configutration.

1.2 Problem Statement

In Malaysia power grid system, most of 85% fault is occurred during the transmission process. This faulty rate should be reduced in order to avoid future loss in cost of maintenance and safety. Thus, in this paper will analyse the most efficient short circuit protection system by comparing the protection relay. The efficient fault clearance time will determine whether the protection scheme capable to protect the system from damage. A coordination study will help to determine the power system selectivity by isolating the fault to the nearest protection devices. [4]

1.3.1 Objectives

On this research paper, the study on the short circuit protection 500kV in peninsular area network is because:

1. To study the 500kV transmission system in Malaysia Network system.
2. To simulate the fault coordination in the power grid system by using POWER WORLD and MATLAB simulation software.
3. To make the comparison of three different relay characteristics.
4. To examine the best type of the relay to be implemented in the transmission system.

1.3.2 Scope Of Study

The project shall begin with the two 11kV power utilities connected to 500kV transmission in a 8 buses simple mesh transmission loop with 275/500kV transformer. The analysis will include the short circuit analysis and coordination study The relay characteristics with discrimination time ranging from 0.5to 0.7 second. In this project, the suggested value is 0.6s of discrimination time. By referring to the standard IEC 60909, the relay must operate not too fast or too slow either there is change in current in too high or too low. The Inverse Time Overcurrent relay characteristics is used to determine the value of fault current in balance three phase fault.

CHAPTER 2

LITERATURE REVIEW

This chapter is discussing about the information and knowledge about short circuit current, 500kV transmission system characteristics. Others researcher result also will be discussed in this chapter.

2.1 Short circuit current

Short circuit current basically happen when there are current travel to the unintended path of the circuit. These paths usually have two different level of electrical impedance, from higher to lower end nodes. On the two nodes with different voltage level, current will be forced to flow towards the lower ends in order to be at the same voltage level. This phenomenon will cause short circuit current to happen. When this phenomenon happens, it may bring damage such as overheating, circuit damage, fire, arcing and even explosion [1]

2.1.1 Type of Short Circuit Current

2.1. Phase-to-Earth Fault

Phase to earth fault may occur when there are connection between one phase to the ground. This is the most common type of fault that happened in the transmission line. Based on the previous study (Paulasaari et al. 1995, winter 1988), it had stated that 50% - 80% of fault happen is phase-to-earth fault.

In the past few years, several methods on locating the earth fault had been created basically by splitting the feeder into sections and closing the substation circuit breaker against the fault until the faulty section is found. The reliability on this method is still in the development phase due to shedding on the customer usage. In the modern method, application of numerical relay and modern current and voltage in practical facilitate greater accuracy and selectively of the protection function. [2]

2.1.1.1.1 Phase-to-Phase fault

Phase to phase fault is occur when there are connection between two phase of the line. The most common cause is the line could make a physical contact due to the broken insulator and ionisation of air.

2.1.2 Detection and Measurement

2.1.2.1 IEC 60909

Short circuit is the non-required or unwanted phenomenon that occurs in the power system. The result of short circuit is capable to cause a serious damage to the whole power system. A systematic and efficient system is needed to identify this phenomenon when it happens. Based on the international standard, to detect a short circuit current in three phase AC system, the IEC (International Electro technical Commission) 60909 is used to calculate and determine the distance of the fault from the substation.[4]

This standard is suitable to be applied to the both low voltage and high voltage AC system. For the high voltage AC system, the limit for this standard is only on 550kV system, if its above the limit, it will be need a special consideration. Another reason that this standard is only applicable to the system those operate at nominal frequency 50HZ or 60Hz.[4]

2.1.2.2 Method of Fault Identification

This standard IEC 60909 is a calculation method of the short circuit fault basically refer to the rated data of the equipment and the topological arrangement of the system. This method is high in accuracy and its analytical character. Basically derived from the Thevenin theorem, the step to is by calculating the equivalent voltage source and then determine the corresponding short circuit current. [4]

In a simpler words, calculation on two short circuit current with different magnitude will be made, they are

(i) The maximum short circuit: to determine the capacity or rating of electrical equipment.