IDENTIFICATION OF THE OPTIMUM PROTECTION CO-ORDINATION IN MEDIUM VOLTAGE DISTRIBUTION SYSTEM OF SRI LANKA

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Degree of Master of Science

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DECLARATION

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(Dr. K.T.M.U. Hemapala)

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ABSTRACT

Majority of the faults in the transmission and distribution network are transient and these faults can be cleared with proper installation of protective devices with appropriate protection settings. It is important to clear the faults as soon as possible by keeping the healthy network undisturbed while avoiding damages to lives and instruments.

It was observed that applying protection settings to Medium Voltage network at Grid Substations and Medium Voltage distribution feeders are done by two separate parties without coordination between them. Monthly tripping summary of 33 kV feeders of Grid Substations of Ceylon Electricity Board revealed that some feeders getting disturbed abnormally. Further, it is observed that Auto Reclosers are installed in downstream of these 33 kV feeders to respond to the transient faults but they are not yielding expected results. Hence, applying most appropriate protection setting to these Auto Reclosers and relays are very much required for the higher reliability of the Medium Voltage network.

Two 33 kV feeders which were mostly disturbed were analyzed deeply and found that most of the feeder trippings are owing to Earth Fault. Further, with installation of temporary Digital Disturbance Recorder, it was observed that most of the faults have lasted less than 100 ms. Plotted Over Current and Earth Fault co-ordination curves for Medium Voltage distribution network disclose that requirement of revising the settings while identifying the most suitable way of applying Auto Reclosers to the 33 kV feeders.

Four scenarios were studied to identify the optimum way of installing Auto Reclosers and protection setting for this Medium Voltage network. Detailed analysis proved that 33 kV feeder with two downstream Auto Reclosers is the optimum solution. Then, the most suitable protection settings for the Medium Voltage network were derived for a typical Grid Substations. Furthermore, an algorithm was defined to find the optimum protection settings for any Grid Substations. Application of these setting to a selected 33 kV feeder viz Feeder 5 of Badulla Grid Substation, proved that the new settings are extremely effective.

Key Words: Medium Voltage distribution, Auto Recloser, Protection settings, Over Current, Earth Fault

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LIST OF ABBREVIATIONS

Abbreviation	Description
AR	Auto Recloser
CB	Circuit Breaker
CEB	Ceylon Electricity Board
CT	Current Transformer
DDR	Digital Disturbance Recorder
DEF	Directional Earth Fault
DOC	Directional Over Current
DT	Definite Time
EF	Earth Fault
EI	Extremely Inverse
F	Feeder
GSS	Grid Sub Stations
HV	High Voltage
IDMT	Inverse Definite Minimum Time
LECO	Lanka Electricity Company (pvt) Limited
LS	Load Shedding
LV	Low Voltage
MV	Medium Voltage
OC	Over Current
PS	Plug Setting
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SBEF	StandBy Earth Fault
SLD	Single Line Diagram
SI	Standard Inverse
TF	Transformer
TMS	Time Multiplier Setting
UF	Under Frequency
VI	Very Inverse

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Chapter 1

INTRODUCTION

1.1 Background

The main purpose of an electrical utility in a country is to supply an un-interrupted power to the end customers. Hence, transmission and distribution network ensure the transferring of the generated electrical power to end users. Power transmission is done in High Voltage (HV) while power distribution is done in Medium Voltage (MV) and Low Voltage (LV) levels. In various countries, these HV, MV and LV levels are defined in various limits but these are approximately same. In Sri Lanka, MV level is defined as 33 kV to 11 kV.

Overhead MV distribution system is subjected to various electrical faults. These faults are mainly categorized in to transient (temporary) faults and permanent faults, depending on the nature of the fault. Transient faults are faults which do not damage insulation permanently while allowing the circuit to safely re-energize after a short period. More than 80% of faults are transient [1] and usually these faults occur when phase conductors are electrically in contact with each other or ground momentary owing to lightning strikes, insulator flashovers, high winds, trees, birds or other animals and so on. On the other hand, permanent faults cause permanent damage to the insulation while damaging equipments which have to be repaired before restoration / re-energize.

Transient faults are cleared by a service interruption for defined small time duration to extinguish the power arc. For this purpose, protective relays having instantaneous or fast tripping and automatic reclosing are used to control the operation of Circuit Breaker (CB). The protective device co-ordination is the process of determining most appropriate timing of power system interruption during abnormal conditions in the power system [2]. Hence, most appropriate protection scheme is required for the