DETECTION OF CROSS-COUNTRY FAULT ON DISTANCE PROTECTION

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DETECTION OF CROSS-COUNTRY FAULT ON DISTANCE PROTECTION

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A thesis submitted in fulfilment of the requirements for the award of the degree of Master of Engineering (Electrical)

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Dedicated to

My parents and kinfolk’s member for their boundless support and encouragement
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ABSTRACT

Distance relay is one of protection components in transmission line. It is widely used as the main protection that gives a tripping signal to the Circuit Breaker (CB) when the fault occurs in the system. When short circuit faults occur in transmission line, the distance relays provide the protection and trip the CB by disconnecting the faulty portion from the healthy section. The main purpose of this research is to find the detection of Cross-Country Fault (CCF) on Distance Protection (DP). During this CCF condition, the faults are in an abnormal condition. This research is performed on a simple circuit model and IEEE test system with 6 buses, 9 buses and 14 bus systems. By using PSCAD/EMTDC software, the Mho characteristics and Bergeron model type of the transmission lines are modelled and have been simulated to generate the output current and voltage that are used to calculate the reach impedance for protected Zone 1. From the simulation results, it can be observed that the fault voltage and current are almost at the same values with the previous research on the normal fault. It means that the voltage and current will become highly fluctuated during the CCF condition. The result analysis is based on CCF with different locations at the same voltage level and CCF with different locations at different voltage levels. To study the performance of CCF condition, the outputs of all types of fault were considered in this project. It is found that the relays in most of the fault’s conditions are operated in the protected zone. Finally, it can be concluded that the effect of CCF on DP are successfully identified.
ABSTRAK

## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td></td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td></td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td></td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF SYMBOLS</td>
<td></td>
<td>xv</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td></td>
<td>xvi</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td></td>
<td>xviii</td>
</tr>
</tbody>
</table>

### 1 INTRODUCTION

1.1 Research Background  
1.2 Problem Statement   
1.3 Objectives of Research  
1.4 Scope of Research   
1.5 Contribution of Research  
1.6 Thesis Outline  

### 2 LITERATURE REVIEW

2.1 Introduction
## Overhead Transmission Lines – Quadruple Tower

2.2

Page 8

## Fault Configuration

2.3

Page 9

## Power System Protection

2.4

Page 11

## Distance Protection

2.5

Page 12

## Distance Relay Protection Principle and Performance

2.6

Page 13

## Zone of Protection

2.7

Page 14

- Zone 1
  2.7.1
  Page 15
- Zone 2
  2.7.2
  Page 16
- Zone 3
  2.7.3
  Page 17

## Distance Relay Characteristics

2.8

Page 18

- Plain Impedance Characteristic
  2.8.1
  Page 19
- Mho Characteristics
  2.8.2
  Page 20
- Offset Characteristic
  2.8.3
  Page 21
- Polarised Mho Characteristic
  2.8.4
  Page 22
- Rectangular (Quadrilateral) Characteristic
  2.8.5
  Page 22
- Lens Characteristic
  2.8.6
  Page 23

## Fault Analysis in Power System

2.9

Page 24

## Summary

2.10

Page 27

### RESEARCH METHODOLOGY

3

3.1

Page 29

## Introduction

3.1

3.2

Page 30

## Process of Analysis

3.2

3.3

Page 31

## PSCAD/EMTDC Software

3.3

3.4

Page 32

## Circuit Design and Construction

3.4

3.5

Page 36

## Summary

3.5

### RESULT AND DISCUSSION

4

4.1

Page 37

## Introduction

4.1

4.2

Page 39

## 132kV Cross-Country Fault with Different Location

4.2

- Single Line to Ground Fault Condition
  4.2.1
  Page 40
- Line to Line Fault Condition
  4.2.2
  Page 42
3.4 Three Phase Fault Condition 43
3.5 Line to Line to Ground Fault Condition 44
3.6 Three Phase to Ground Fault Condition 45
3.7 132kV-275kV Cross-Country Fault with Different Location Compared with 132kV Cross-Country Fault Condition 46

4.3 IEEE Test System Discription 54
4.4 6 Bus Test System 54
4.4.1 Cross-Country Fault with Different Location 56
4.4.2 Cross-Country Fault with Different Voltage Levels 59
4.4.3 9 Bus Test System 62
4.4.4 Cross-Country Fault with Different Location 63
4.4.5 Cross-Country Fault with Different Voltage Levels 66
4.4.6 14 Bus Test System 70
4.4.7 Cross-Country Fault with Different Location 71
4.4.8 Cross-Country Fault with Different Voltage Levels 74
4.5 Summary 77

5 RESULTS AND DISCUSSION
5.1 Summary 79
5.2 Significant of Research Output 80
5.3 Suggestion for Future Works 81

REFERENCES 82
Appendices A-B 88-96
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Calculation for Apparent Impedance</td>
<td>38</td>
</tr>
<tr>
<td>4.2</td>
<td>Output for 6 busses Transmission Line System with Different Location</td>
<td>56</td>
</tr>
<tr>
<td>4.3</td>
<td>Output for 6 busses Transmission Line System with Different Voltage levels</td>
<td>59</td>
</tr>
<tr>
<td>4.4</td>
<td>Output for 9 busses Transmission Line System with Different Location</td>
<td>64</td>
</tr>
<tr>
<td>4.5</td>
<td>Output for 9 busses Transmission Line System with Different Voltage levels</td>
<td>67</td>
</tr>
<tr>
<td>4.6</td>
<td>Output for 14 busses Transmission Line System with Different Location</td>
<td>71</td>
</tr>
<tr>
<td>4.7</td>
<td>Output for 14 busses Transmission Line System with Different Voltage levels</td>
<td>74</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Quadruple Tower</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Condition of Each Types of Fault</td>
<td>10</td>
</tr>
<tr>
<td>2.3</td>
<td>3-Zone Distance Protection Scheme</td>
<td>15</td>
</tr>
<tr>
<td>2.4</td>
<td>Plain Impedance Characteristics</td>
<td>19</td>
</tr>
<tr>
<td>2.5</td>
<td>Mho Characteristics</td>
<td>20</td>
</tr>
<tr>
<td>2.6</td>
<td>Offset Mho Characteristics</td>
<td>21</td>
</tr>
<tr>
<td>2.7</td>
<td>Quadrilateral Characteristic</td>
<td>23</td>
</tr>
<tr>
<td>2.8</td>
<td>Lens Characteristic</td>
<td>23</td>
</tr>
<tr>
<td>3.1</td>
<td>Voltage Sources</td>
<td>29</td>
</tr>
<tr>
<td>3.2</td>
<td>Voltage Sources Configuration</td>
<td>31</td>
</tr>
<tr>
<td>3.3</td>
<td>Flow of Research</td>
<td>33</td>
</tr>
<tr>
<td>3.4</td>
<td>Main Circuit</td>
<td>33</td>
</tr>
<tr>
<td>3.5</td>
<td>Control Circuit</td>
<td>34</td>
</tr>
<tr>
<td>3.6</td>
<td>Relay Circuit</td>
<td>35</td>
</tr>
<tr>
<td>4.1</td>
<td>Simple Single Line Diagram Modelling</td>
<td>39</td>
</tr>
<tr>
<td>4.2</td>
<td>Time Occur and Trip Signal</td>
<td>40</td>
</tr>
<tr>
<td>4.3</td>
<td>Output Voltage and Current for Single Line to Ground</td>
<td>41</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Distance Protection Relay for Single Line to Ground</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>Output Voltage and Current for Line to Line</td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>Distance Protection Relay for Line to Line</td>
<td></td>
</tr>
<tr>
<td>4.7</td>
<td>Output Voltage and Current for Three Phase</td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>Distance Protection Relay for Three Phase</td>
<td></td>
</tr>
<tr>
<td>4.9</td>
<td>Output Voltage and Current for Line to Line to Ground</td>
<td></td>
</tr>
<tr>
<td>4.10</td>
<td>Distance Protection Relay for Line to Line to Ground</td>
<td></td>
</tr>
<tr>
<td>4.11</td>
<td>Output Voltage and Current for Three Phase to Ground</td>
<td></td>
</tr>
<tr>
<td>4.12</td>
<td>Distance Protection Relay for Three Phase to Ground</td>
<td></td>
</tr>
<tr>
<td>4.13</td>
<td>Fault Time and Trip Signal</td>
<td></td>
</tr>
<tr>
<td>4.14</td>
<td>Single Line Diagram 132kV-275kV Cross-Country Fault</td>
<td></td>
</tr>
<tr>
<td>4.15</td>
<td>Output Simulation in normal condition (a) current and voltage waveform (b) distance protection in zone 1</td>
<td></td>
</tr>
<tr>
<td>4.16</td>
<td>Output Simulation in Different Location for Single Line (a) current and voltage waveform (b) distance protection in zone 1</td>
<td></td>
</tr>
<tr>
<td>4.17</td>
<td>Output Simulation in Different Voltages for Single Line (a) current and voltage waveform (b) distance protection in zone 1</td>
<td></td>
</tr>
<tr>
<td>4.18</td>
<td>Output Simulation in Different Location for Double Line (a) current and voltage waveform (b) distance protection in zone 1</td>
<td></td>
</tr>
<tr>
<td>4.19</td>
<td>Output Simulation in Different Voltages for Double Line (a) current and voltage waveform (b) distance protection in zone 1</td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.20</td>
<td>Output Simulation in Different Location for Three Phase (a) current and voltage waveform (b) distance protection in zone 1</td>
<td>51</td>
</tr>
<tr>
<td>4.21</td>
<td>Output Simulation in Different Voltages for Three Phase (a) current and voltage waveform (b) distance protection in zone 1</td>
<td>51</td>
</tr>
<tr>
<td>4.22</td>
<td>Output Simulation in Different Location for Double Line to Ground (a) current and voltage waveform (b) distance protection in zone 1</td>
<td>52</td>
</tr>
<tr>
<td>4.23</td>
<td>Output Simulation in Different Voltages for Double Line to Ground (a) current and voltage waveform (b) distance protection in zone 1</td>
<td>52</td>
</tr>
<tr>
<td>4.24</td>
<td>Output Simulation in Different Location for Three Phase to Ground (a) current and voltage waveform (b) distance protection in zone 1</td>
<td>53</td>
</tr>
<tr>
<td>4.25</td>
<td>Output Simulation in Different Voltages for Three Phase to Ground (a) current and voltage waveform (b) distance protection in zone 1</td>
<td>53</td>
</tr>
<tr>
<td>4.26</td>
<td>Single line diagram of the IEEE 6 bus System</td>
<td>55</td>
</tr>
<tr>
<td>4.27</td>
<td>6 Busses IEEE Test System PSCAD Modeling</td>
<td>55</td>
</tr>
<tr>
<td>4.28</td>
<td>Single line diagram of the IEEE 9 bus System</td>
<td>62</td>
</tr>
<tr>
<td>4.29</td>
<td>9 Busses IEEE Test System PSCAD Modeling</td>
<td>63</td>
</tr>
<tr>
<td>4.30</td>
<td>Single line diagram of the IEEE 14 bus System</td>
<td>70</td>
</tr>
<tr>
<td>4.31</td>
<td>14 Busses IEEE Test System PSCAD Modeling</td>
<td>70</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DP</td>
<td>Distance Protection</td>
</tr>
<tr>
<td>CCF</td>
<td>Cross-Country Fault</td>
</tr>
<tr>
<td>CAES</td>
<td>Compressed air energy storage</td>
</tr>
<tr>
<td>MW</td>
<td>Mega watt</td>
</tr>
<tr>
<td>GW</td>
<td>Giga watt</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineering</td>
</tr>
</tbody>
</table>
## LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Publication</td>
<td>87</td>
</tr>
<tr>
<td>B</td>
<td>Appendix A</td>
<td>88</td>
</tr>
<tr>
<td>C</td>
<td>Appendix B</td>
<td>96</td>
</tr>
</tbody>
</table>
CHAPTER 1

Introduction

1.1 Research Background

The double line circuit on the same tower are widely used in transmission line system. It may enhance the transmission capacity of each way, other than to reduce the usage of ground and can cost reduction. The lines that share the same portion, their length are or structure are defined as a double circuit transmission lines [1].

Based on this situation, there are about 120 kinds of faults occurred in double circuit lines, due to the existence of the cross-country fault (CCF) [1,2]. It is very complicated to calculate and analyze the fault that occurred in double circuit lines and very important to study the characteristics of cross-country fault first.

The fault that is involving different phase and occurring at two different locations in power system can be defined as a cross country fault [1-3]. In this case, the differential protection must trip only for fault that occurs in protected zone, but sometimes it may not trip the internal faults or trip the external faults incorrectly.
These faults often occur at a worst possible time and locations. Sometimes, it will occur with maximum amount of current and cause big damages. Electric utilities often face the problem due to fault that always occur in transmission lines. Sometimes, these faults often cause the maximum amount of inconvenience and occur at the worst possible time to the customer utility.

In order to protect the components in transmission lines from damages, distance protection relays are used and operated within a certain distance. The distance protection is a non-unit system of protection which offers considerable economic and technical advantages.

The protected circuit located along the distance protection relays also is a comparatively simple to apply and can be fast in operation. In transmission system, the distance protection works by utilizing the fact that the measured impedance from a point directly in proportional to the distance. The location and operating systems can be measured by comparing it with the setting impedance.

### 1.2 Problem Statement

Parallel transmission lines have been extensively utilized in modern power systems to enhance the reliability and security for the transmission of electrical energy. The challenging problems in the power system protection are when the parallel lines in different possible configurations are combined with the effect of the mutual coupling. The main sources of the problem are when the possibility of the occurrence of CCF and the mutual coupling are occurs in transmission line.

From the previous research, most of the research is conducting in normal fault condition. The research for CCF are rarely conducted especially
the research in distance protection transmission line system area. This research proposed the effect of CCF in transmission line and the result of the analysis will be compared with the analysis of the basic fault. The performance and the behaviour of the fault in the distance protection during CCF condition are also being considered.

1.3 Objectives of The Research

The main objective of the proposed research is to identify the effect of cross-country fault on distance protection. To achieve the objective, sub-objectives are as follows:

a) To study and understand the cross-country fault condition
   The current and voltage fluctuate very high during the CCF condition. The distance protection will detect the abnormal condition and the output value will be calculated in order to detect the CCF condition.

b) To simulate cross-country fault using PSCAD/EMTDC
   This software is a standard simulation for the study of the electrical behaviour. By using this software, the value of the current and voltage detected can easily be calculated in order to detect the CCF on distance protection.

c) To find and analyze the effect of cross-country fault on distance protection
   After modeling the system using software, the result will be analyzed and recorded. When the CCF occurs in transmission line, the distance protection will detect the abnormal fault and the breaker will automatically trip. From that, the value will be calculated and the distance protection will detect the fault either it occurs inside or
outside the protection zone. Then, the result will be compared with the previous normal fault condition.

1.4 **Scope of Research**

The scope of this research can be divided into two parts. Firstly, the different types of faults that occur at transmission are simulated. There are about 120 kinds of faults occurred in double circuit lines due to the existence of the cross-country fault [1,4,7]. These faults may occur at the worst possible time and can cause the maximum amount of inconvenience to the customer utility.

The next stage is to find the function for distance relaying protection if there are faults that occur at double circuit transmission lines. In order to protect the components from damages caused from faults, the distance protection relays have used and operated within a certain distance. Distance protection relays also is a comparatively simple to apply and can be fast in operation for faults located along most of the protected circuit.

In this research, the PSCAD/EMTDC software has been used for analytical simulations. The analysis of this research consists of IEEE buses transmission line power system including 6-bus, 9-bus and also 14-bus system. Using this software, the analysis has been done by simple model that represent the real system.
1.5 Contributions of Research

As mentioned earlier under the research background, the double circuit line on the same tower are widely used in transmission line system. The possiblity of faults occured between lines is very high. This is called as cross-country faults, which is a fault that occur at tower involving the different location of faults or in different type of voltage levels. Most of the previous research are based on the normal fault condition that occurs in transmission line. This research has been be carried out because:

a) Analysis on detection of cross-country fault on distance relays
b) The comparisions between fault and cross-country fault being analyzed and the detection of the CCF being simulated

This study should be carried out due to previous studies focused on five types of fault that occur in a location on same tower and voltage; which is single line to ground, double line to ground, three phase to ground, double line fault and three line fault.

1.6 Thesis Outline

This thesis is divided into five chapters. Every chapter has its own strength. For the first chapter, the introduction of the research is covered. Its including the objectives of the research and also the contributions for the research. The second chapter will discuss the entire subject that contributed in this research as stated in the literature review. From this chapter, the teoritical regarding the research will be discussed. The previous research is also being discussed in detail. The third chapter is about the methodology of the research that covers the software used for the simulation and its related library tools that has been used in the simulation. The purposed of choosing this software
is also being discussed and the model that has been used during the simulation is also being clarified in this chapter.

Chapter 4 will discuss on the result and discussion of this research. During the simulation, the output result will be compared with the normal fault and the previous works output. The results is based on the IEEE test system which consist of 6-bus, 9-bus and 14-bus test systems. All the results will be recorded in this chapter. Chapter five will conclude all the information regarding to this project. The recommendation for the future development and study are also being discussed in this final chapter.
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