IDENTIFICATION OF CAUSES OF DISTRIBUTION TRANSFORMER FAILURES AND INTRODUCTION OF MEASURES TO MINIMIZE FAILURES

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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M.V.P.G Udayakanthi
Date: 25th March 2014

The above candidate has carried out research for the Masters dissertation under my supervision.

Prof. J.R Lucas
Senior Professor,
University of Moratuwa
ABSTRACT

Distribution Transformers are costly and critical equipments in electricity distribution network. The Ceylon Electricity Board (CEB) has nearly 24,500 number of distribution transformers installed island wide which are connected to 11kV or 33kV Medium Voltage (MV) networks to meet the present power demand of consumers.

Failure of a distribution transformer results to interruption of power supply to the consumers and involve high expenditure in repair or replacement of transformer. Hence protection of distribution transformer is very important. Transformer failure rate of the CEB is nearly 2.5% where internationally acceptable level is less than 2%.

When a Distribution Transformer is failed, it is replaced with a new transformer, but there is no proper method established by the CEB to analyze the cause of failure. A detailed investigation of failed transformer is vital important to understanding the actual failure scenario and prevent further incidents.

The objective of the study was to identify main causes of distribution transformer failures and propose measures to minimize those failures. This thesis presents the CEB distribution substation installation practices and practical situation of distribution substations which would be the causes for failures. Detail investigation procedure for failed transformers was established in order to find out exact cause for each transformer failure.

Through the literature review, different failure modes were identified for each transformer component and common transformer failure causes are lightning, short circuit faults in network, aging, overloading, oil leaks, loose connections and bad workmanship. Failed transformers during the year 2011 were inspected in order find the root causes for failures.

It was observed that lightning and overloading are the major causes for transformer failures in Southern Province. It was observed that 28% of transformer failures are due to lightning and 25% are due to overloading.

Onsite investigations were carried out and failed transformers were opened whenever necessary to identify the exact causes for failures. Several tests were done before opening failed transformers such as insulation resistant test, polarization index test, ratio test and LV short circuit test.

To minimize transformer failures, several measures were proposed. Maintaining the surge arrestor earth electrode resistance less than $10\,\Omega$, replacing of faulty surge arrestors, installation of LV surge arrestors, proper fuse selection, balancing of loads, and proper crimping of lugs are few recommendations. It is strictly recommended to train the field staff to follow the CEB construction standards of distribution substations when constructing as well as doing operation and maintenance works.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration</td>
<td>i</td>
</tr>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>iii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>vii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>ix</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>x</td>
</tr>
<tr>
<td>1. Introduction</td>
<td></td>
</tr>
<tr>
<td>1.1 Background</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Problem Statement</td>
<td>2</td>
</tr>
<tr>
<td>1.3 Motivation</td>
<td>3</td>
</tr>
<tr>
<td>1.4 Objective</td>
<td>3</td>
</tr>
<tr>
<td>1.5 Scope of Work</td>
<td>4</td>
</tr>
<tr>
<td>2. Literature Review</td>
<td>5</td>
</tr>
<tr>
<td>2.1 Distribution Transformer</td>
<td>5</td>
</tr>
<tr>
<td>2.2 Distribution Transformer Components</td>
<td></td>
</tr>
<tr>
<td>2.2.1 Core</td>
<td>7</td>
</tr>
<tr>
<td>2.2.2 Windings</td>
<td>7</td>
</tr>
<tr>
<td>2.2.3 Transformer Tank</td>
<td>8</td>
</tr>
<tr>
<td>2.2.4 Tap Changer</td>
<td>8</td>
</tr>
<tr>
<td>2.2.5 Bushings</td>
<td>9</td>
</tr>
<tr>
<td>2.2.6 Pressure Relief Valve</td>
<td>10</td>
</tr>
<tr>
<td>2.3 Overview of Transformer Operation</td>
<td>10</td>
</tr>
<tr>
<td>2.4 Transformer Protection</td>
<td>12</td>
</tr>
<tr>
<td>2.4.1 Fuse Protection</td>
<td>15</td>
</tr>
<tr>
<td>2.4.2 Surge Protection</td>
<td>19</td>
</tr>
<tr>
<td>2.4.3 Earthing of Substation</td>
<td>21</td>
</tr>
<tr>
<td>2.5 Transformer Failure Modes</td>
<td>22</td>
</tr>
<tr>
<td>2.5.1 Core</td>
<td>22</td>
</tr>
<tr>
<td>2.5.2 Winding</td>
<td>23</td>
</tr>
</tbody>
</table>
5.3.4 Timely Planning 60
5.3.5 Balancing of Transformer Loads 60
5.4 Prevention of Oil Leakages 61
5.4.1 Corrosion of Transformer Tank 61
5.4.2 Oil Leak through Drain Valve 62
5.4.3 Oil Leak through Bushing Gaskets 62
5.5 Good Workmanship Practices 63
5.5.1 Crimping of Lugs 63
5.5.2 Proper Torque of Bolted Connections 64
5.5.3 Corrosion of Nuts and Bolts 65
5.6 Increase the Quality of Fabrication of transformers 65
5.7 Advantages of Reduction of Transformer Failures 66

6 Conclusion 67
6.1 Conclusion and Discussion 67
6.2 Recommendations 69

References List 70
Appendices

Appendix 1 Format of transformer failure report 71
Appendix 2 Format of detail investigation report 72
Appendix 3 Format of test report for failed transformer 74
Appendix 4 Format of test report for repaired transformer 75
Appendix 5 List of failed transformers in 2011 76
Appendix 6 Distribution Transformer Failures in NWP, WPS1, WPS2, SG and SP – 2011 78
Appendix 7 Thunder days in Galle, Hambantota Meteorological Stations 79
| Figure 2.1: Pole mounted distribution transformer | Page 6 |
| Figure 2.2: Typical arrangement of distribution substation | Page 6 |
| Figure 2.3: Stacking of transformer core | Page 7 |
| Figure 2.4: Assembling three windings | Page 8 |
| Figure 2.5: Wiring diagram of a tap changer | Page 9 |
| Figure 2.6: Primary bushing | Page 9 |
| Figure 2.7: Secondary bushing | Page 10 |
| Figure 2.8: Coupling between a transformer coils and its core | Page 10 |
| Figure 2.9: Damage and Inrush curves for 33/0.4kV160kVA transformer | Page 15 |
| Figure 2.10: Time Current Characteristics curves | Page 16 |
| Figure 2.11: DDLO type expulsion fuse | Page 17 |
| Figure 2.12: HRC fuses | Page 18 |
| Figure 2.13: Fuse switch disconnector | Page 19 |
| Figure 2.14: Two different practices of positioning the surge arrestor | Page 20 |
| Figure 2.15: Common transformer earthing practices | Page 21 |
| Figure 2.16: Investigation flow chart | Page 28 |
| Figure 4.1: Average thunder days – Galle Meteorological station and Average transformer failures of Galle, Matara districts (during 2007 to 2011) | Page 34 |
| Figure 4.2: Average thunder days – Hambantota Meteorological station and Average transformer failures of Hambantota districts (during 2007 to 2011) | Page 35 |
| Figure 4.3: Age wise details of distribution transformer failures in SP | Page 36 |
| Figure 4.4: Age wise analysis of distribution transformer failures in SP | Page 36 |
| Figure 4.5: Arrestor mounted on transformer tank and cross arm | Page 40 |
| Figure 4.6: Middle limb of transformer windings displaced | Page 41 |
| Figure 4.7: DDLO switch of the middle phase with “gal mattu” | Page 42 |
| Figure 4.8: Cable directly connected without HRC fuse | Page 42 |
| Figure 4.9: Tear down inspection of the failed transformer | Page 48 |
Figure 4.10: Transformer that removed from service due to corrosion 50
Figure 4.11: Oil leaked transformer and its corroded fins 51
Figure 4.12: Oil leaked through LV bushing gaskets 51
Figure 4.13: Oil leaked through LV bushing gasket of failed transformer due to bad connections 53
Figure 4.14: Transformer with wrong connection of wires and failed transformer due to excessive heat of connection 54
Figure 4.15: Failed transformer at Silvary substation 55
Figure 5.1: LV surge arrestor installed at Gongala (TNL transmission station) 58
Figure 5.2: Sectional view of current practice of cover plate design 63
Figure 5.3: Sectional view of proposed cover plate design 63
Figure 5.4: ABC lugs 63
Figure 5.5: Five ton bundle tool and dies 64
Figure 5.6: Tail wire connection to flags 64
LIST OF TABLES

Table 1.1: Distribution transformer data of Southern Province .......................... 2
Table 2.1: Primary and secondary current of different transformer capacities .......... 11
Table 2.2: Protection devices of distribution transformer .................................... 12
Table 2.3: Transformer categories ................................................................. 13
Table 2.4: Short time thermal load capability of oil immersed transformers .......... 13
Table 2.5: Fuse ratings used for CEB 33kV transformer ................................... 17
Table 2.6: Fuse ratings used for CEB 11kV transformer ................................... 18
Table 2.7: Failure causes and failure modes of core ...................................... 23
Table 2.8: Failure causes and failure modes of windings ................................. 23
Table 2.9: Failure causes and failure modes of transformer tank ....................... 24
Table 2.10: Failure causes and failure modes of solid insulation ....................... 24
Table 2.11: Failure causes and failure modes of oil insulation ......................... 25
Table 2.12: Failure causes and failure modes of bushings .............................. 26
Table 3.1: Polarization index values .............................................................. 31
Table 4.1: Distribution transformer data of NWP, WPS1, SG, WPS2 and SP for year 2011 ........... 33
Table 4.2: Transformer failures in Southern Province from 2007 to 2011 ............ 34
Table 4.3: Age wise details of distribution transformer failures in SP .................. 36
Table 4.4: Transformer failures in capacity wise ........................................ 37
Table 4.5: Surge arrestor and neutral earth resistance of substations that suspect failed due to lightning .......... 39
Table 4.6: Transformer failure rate of some CSC in SP .................................. 39
Table 4.7: Relative ageing rate with hot-spot temperature ............................. 44
Table 4.8: Current and temperature limitations for normal loading transformers ... 46
Table 4.9: Load reading of some transformers that were failed due to overload ........ 47
Table 4.10: Load reading of Gamdoragama New substation at night peak .......... 49
Table 5.1: Transformer earth electrode resistances ....................................... 56
Table 5.2: Examples to transformers having 1 phase overloaded in Amb. Area ...... 61
Table 5.3: Annual cost saving ................................................................. 66
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Arial Bundle Conductor</td>
</tr>
<tr>
<td>AC</td>
<td>Alternative Current</td>
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<tr>
<td>AMU</td>
<td>Area Maintenance Unit</td>
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<tr>
<td>CEB</td>
<td>Ceylon Electricity Board</td>
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<tr>
<td>CSC</td>
<td>Consumer Service Center</td>
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<tr>
<td>DC</td>
<td>Direct Current</td>
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<tr>
<td>DDLO</td>
<td>Drop Down Lift Off</td>
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<tr>
<td>DP</td>
<td>Degree of polymerization</td>
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<td>HRC</td>
<td>High Rupturing Capacity</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineers</td>
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<tr>
<td>LECO</td>
<td>Lanka Electricity Company</td>
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<tr>
<td>LV</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>MCCB</td>
<td>Molded Case Circuit Breaker</td>
</tr>
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<td>MV</td>
<td>Medium Voltage</td>
</tr>
<tr>
<td>NWP</td>
<td>North Western Province</td>
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<td>SG</td>
<td>Sabaragamuwa Province</td>
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<tr>
<td>SP</td>
<td>Southern Province</td>
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<tr>
<td>SS</td>
<td>Stainless Steel</td>
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<td>TCC</td>
<td>Time Current Characteristic</td>
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<tr>
<td>TMU</td>
<td>Transformer Maintenance Unit</td>
</tr>
<tr>
<td>TIG</td>
<td>Tungsten Inert Gas</td>
</tr>
<tr>
<td>WPS 1</td>
<td>Western Province South 1</td>
</tr>
<tr>
<td>WPS 2</td>
<td>Western Province South 2</td>
</tr>
</tbody>
</table>