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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Date: 25th March 2014

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

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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 actual 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 10Ω, 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

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

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