IMPACT"O'F 1MBEDDED GENERATION ON 33 KV DISTRIBUTION SYSTEM VOLTAGE

By

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This thesis was submitted to the department of Electrical Engineering in partial fulfillment of the requirements for the Degree of Master of Engineering

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Abstract

Recently introduced schemes of Embedded Generation on the radial distribution lines have several remarkable advantages though· they produce some of the technical problems on the network. One of the major problems encountered is the variation of steady state voltage during the switching on/off operation of the Embedded Generators. The consumers connected on the line are subjected to larger variations during such operations. This research focuses on the study of the steady state voltage variation patterns and proposes solutions to mitigate the problem.

The utilities impose several standards and require meeting specifications in connecting generators on the distribution network. Focusing on the effects on the locally connected COnStHl1erSto the network, both domestic and industrial, they are subjected to most of the prevailing technical problems arisen out of connecting Generators on the lines.

Mainly, the problem of steady state voltage variations experienced by the consumer and finding ways of mitigating the same is discussed in this research paper. Data collection, application of load flow theories, modelling in SynerGEE software, analysis, application of mitigate measures on the model and the conclusion of the outcome of the research work are presented.

A statistical way of approach is used to obtain the percentage of consumers affected in the case studies undertaken during the study. Recommendations are made that lead to mitigation of the problem concerned.

CONTENTS

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P. S. S. CHANDRARATNE

PE/EE/17/00

DECLARATION

In accordance with the requirements of the Master of Engineering (Electrical) of the University of Moratuwa, Sri Lanka, I produce the following thesis titled "Impact of Embedded Generation on 33 kV Distribution System Voltage".

This work was performed under the supervision of Prof. J. R. Lucas and Dr H. Y. R. Perera of the Department of Electrical Engineering, University of Moratuwa. I declare that the work submitted in this research paper is my own to the best except as acknowledged in the text and footnotes etc., and have not been previously submitted for a degree at the University of Moratuwa or any other institution.

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Abbreviations and Symbols used

Abbreviation/ Symbol	Description
CEB	Ceylon Electricity Board
GSS	Grid Substation
EG	Embedded Generation
kV	kilo Volts
kVA	kilo volt amperes
kW	kilo Watt
kvar	Kilo volt ampere reactive Power
PT	Potential Transformer
CT	Current Transformer
LDC	Line Drop Compensator
LTC	Load Tap Changer
P_S	Sending End Active Power (kW)
Q_S	Sending End Reactive Power (kvar)
P_R	Receiving End Active Power (kW)
Q_R	Receiving End Reactive Power (kvar)
P_G	Generator Active Power (kW)
P_{Gen}	Active Power of the Generator connected
P_{Load}	Active Power consumed by the load
P_{Losses}	Active Power lost in the system
Q_G	Generator Reactive Power (kvar)
Q_{Gen}	Reactive Power of the Generator connected
Q_{Load}	Reactive Power consumed by the load
Q_{Losses}	Reactive Power lost in the system
R	Resistance of the line
δ	Voltage Angle
$\overline{X}$	Average value of a set of data
X	Reactance of the line
V_S	Sending end Voltage

V_R	Receiving end Voltage
σ	Standard Deviation of a set of data
C_V	Coefficient of Variation of a set of data

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