A STUDY ON ELECTRICITY QUALITY PROBLEMS PRODUCED BY CAPACITOR SWITCHING AND PROTECTION SYSTEM FALSE OPERATION

By

Eng. Khaled Galal Ahmed Ghaly

A Thesis Submitted to the Faculty of Engineering at Cairo University

In partial Fulfillment of the Requirements for the Degree of

Master of Science
In
Electrical Power and Machines Engineering

Faculty of Engineering, Cairo University
Giza, Egypt
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Under the Supervision of

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Summary:

Capacitor switching is one of the most important sources of generating transient overvoltage and inrush current of electrical power system. Energizing transient may reduce the life span of capacitor banks, damage of power system equipment and insulation failure**.** This thesis, presents three technologies used to mitigate transients caused by capacitor switching. ATP program is used to simulate capacitor switching with and without utilizing mitigating methods. On the other hand, this thesis also aims to study the influence of harmonic distortion of non-linear loads on differential relays during internal faults with power transformers such as ground fault in protected zone and winding faults. There are many factors that are considered in the transformer differential protection designing like type of transformer connection, phase shifting and transformer neutral. Presence of harmonic current particularly 2^{nd} and 5^{th} harmonic distortions of current during faults may cause mal-operation or measurement errors relative to protective devices and cause control of monitoring equipment to register improperly.

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List of Abbreviations and Symbols

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronics Engineers
υ	Circuit Breaker Voltage at Closing Instant
ω	Natural Frequency
z_o	Surge Impedance
CT	Current Transformer
IEC	International Electro-technical Commission
HV	High Voltage
PSCAD	Power Systems Computer Aided Design
EMTDC	Electromagnetic Transients Including DC
p	Detuning Factor
f	Frequency
Qcn	Rated Reactive Power of Capacitor
Ucn	Rated Voltage of Capacitor
C	Capacitance of the Capacitor
X_C	Capacitance of Reactor
X_L	Inductance of Reactor
I_{max}	Inrush Current
f_{inrush}	Inrush Frequency
CB	Bank Capacitance
Ls	The System Inductance
ATP	Alternative Transients Program

P.F	Power Factor
T_C	Closing Time
EMTP	Electromagnetic Transients Program
SCT	Specially Connected Transformers
H	Harmonic Order
I_1	Fundamental Frequency Load Current
I_h	Harmonic Current