A benchmarking model for harmonic distortion in a power system

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ABSTRACT

The present power system is loaded with sophisticated energy conversion technologies like solid state converters. With the rapid advance in semiconductor technology, power electronics have provided new devices that are highly efficient and reliable. These devices are inherently non-linear, which causes the current to deviate from sinusoidal conditions. This phenomenon is known as harmonic current distortion.

Multiple consumers are connected to the utility at the point of common coupling. Harmonic currents are then transmitted into the distribution system by various solid state users and this could lead to voltage distortion. Harmonic distortion is just one of the power quality fields and is not desirable in a power system. Distortion levels could cause multiple problems in the form of additional heating, increased power losses and even failing of sensitive equipment.

Utility companies like Eskom have power quality monitors on various points in their distribution system. Data measurements are taken at a single point of delivery during certain time intervals and stored on a database. Multiple harmonic measurements will not be able to describe distortion patterns of the whole distribution system. Analysis must be done on this information to translate it to useful managerial information.

The aim of this project is to develop a benchmarking methodology that could aid the supply industry with useful information to effectively manage harmonic distortion in a distribution system. The methodology will implement distortion indexes set forth by the Electrical Power Research Institute [3], which will describe distortion levels in a qualitative and quantitative way. Harmonic measurements of the past two years will be used to test the methodology. The information is obtained from Eskom's database and will benchmark the North-West Province distribution network [40]. This proposed methodology will aim to aid institutions like NERSA to establish a reliable power quality management system.

Keywords: Benchmarking indices, harmonics, voltage distortion, current distortion, power quality

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LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
AHC	Active Harmonic Conditioners
BI	Benchmarking Indices
CFL	Compact Fluorescent Lights
CL	Compatibility Level
CP	Cumulative Probability
CT	Current Transformer
DC	Direct Current
DPQ	Distribution Power Quality
DSP	Digital Signal Processor
E	Emission Limit
EHV	Extra High Voltage
EL	Emission Level
EMC	Electromagnetic Compatibility
EPRI	Electrical Power Research Institute
HV	High Voltage
I	Immunity Limit
IEC	International Electrotechnical Commission
IEEE	The Institute for Electrical and Electronic Engineers
IGBT	Insulated Gate Bipolar Technology
IL	Immunity Level
ITHD	Current Total Harmonic Distortion
LV	Low Voltage
MCB	Miniature Circuit Breaker
MV	Medium Voltage
NER	National Electricity Regulator
NERSA	National Energy Regulator of South Africa
PCC	Point of Common Coupling
PFC	Power Factor Correction
PL	Planning Level
PoD	Point of Delivery
PQ	Power Quality
PQMS	Power Quality Management System
PQSE	Power Quality State Estimator
QoS	Quality of Supply
RCCB	Residual Current Circuit Breaker
RMS	Root Mean Square

Abbreviation	Description
SANS	South African National Standards
SMPS	Switch Mode Power Supply
SVC	Static VAR Compensator
TDD	Total Distortion Demand
THD	Total Harmonic Distortion
VSD	Variable Speed Drive
VT	Voltage Transformer
VTHD	Voltage Total Harmonic Distortion