

2006

# Investigation of data reporting techniques and analysis of continuous power quality data in the Vector distribution network

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## Recommended Citation

Nicholson, Glenn, Investigation of data reporting techniques and analysis of continuous power quality data in the Vector distribution network, M. Eng. thesis, School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, 2006.  
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# **Investigation of Data Reporting Techniques & Analysis of Continuous Power Quality Data in the Vector Distribution Network**

A thesis submitted in fulfilment of the requirements for the award of the  
degree of

**Master of Engineering (Research), Electrical**

from

**UNIVERSITY OF WOLLONGONG**

by

Glenn Nicholson, B Eng Tech

School of Electrical, Computer & Telecommunication Engineering

## **Certification**

I, Glenn C Nicholson, declare that this thesis, submitted in fulfilment of the requirements of Master of Engineering (Research), in the School of Electrical, Computer & Telecommunications Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

A handwritten signature in black ink, appearing to read 'G Nicholson', with a small flourish at the end.

Glenn C Nicholson

21 March 2006

## Table of Contents

	<b>Page</b>
Certification	i
List of figures	vi
List of tables	vii
List of abbreviations	ix
Abstract	x
Acknowledgements	xii
<b>Chapter 1: Introduction</b>	<b>1</b>
1.1 What is Power Quality	1
1.2 Types of PQ disturbances	2
1.3 Power Quality Monitoring and Benchmarking	4
1.4 The Vector Power Quality Analysis Project	5
1.5 Methodology	6
1.6 Scope of this thesis	7
1.7 Original contributions in this thesis	9
<b>Chapter 2: Power Quality for Utilities: A Literature Review</b>	<b>11</b>
2.1 Introduction	11
2.2 Methodologies for utility power quality surveys	12
2.2.1 Where to measure	13
2.2.2 What to monitor	15
2.2.3 How to measure	16
2.3 Power quality analysis techniques	17
2.3.1 Measurement and analysis of discrete PQ events	18
2.3.2 Analysis of continuous power quality data	24
2.4 Power quality network indices and PQ reporting	39
2.4.1 System indices	40
2.5 Conclusion	43
	<b>Page</b>

<b>Chapter 3: Power Quality Standards</b>	45
3.1 Introduction	45
3.2 The role of power quality standards	46
3.3 Organisations responsible for the development of power quality standards	47
3.4 International power quality standards	48
3.4.1 IEC standards	49
3.4.2 IEEE standards	51
3.4.3 CENELEC standards	51
3.5 New Zealand power quality regulations and standards	53
3.5.1 Voltage rules and regulations	54
3.5.2 Voltage fluctuation (flicker) levels	55
3.5.3 Voltage unbalance rule	55
3.5.4 Harmonics rule	56
3.5.5 Transient overvoltages	56
3.5.6 AS/NZS 61000.2.2	58
3.5.7 AS/NZS 61000.3.6	59
3.5.8 AS/NZS 61000.3.7	61
3.6 Instrumentation standards	62
3.7 Standards and power quality on the Vector network	62
3.7.1 Voltage variation	63
3.7.2 Voltage unbalance	64
3.7.3 Harmonics	64
3.7.4 Vector power quality objectives and planning levels	65
3.8 Conclusions	67
 <b>Chapter 4: Power Quality Monitoring Instrumentation     and Data Acquisition</b>	 70
4.1 Introduction	70
4.2 Planning a utility power quality survey	71
4.2.1 What should be measured?	71
	<b>Page</b>

4.2.2	Where to measure?	72
4.2.3	How long should the monitoring take place?	73
4.3	PQ instrument requirements	73
4.4	Transducers	75
4.5	Power quality instrument standards	75
4.5.1	IEC 61000-4-30	76
4.5.2	AS/NZS 61000-4-7	78
4.6	Power quality monitoring on a utility network	80
4.6.1	Power quality monitoring at Vector	81
4.6.2	Assessment of the ION 7700 and 7600 meters	85
4.7	Data acquisition and recording issues	85
4.7.1	Abnormal data	85
4.7.2	Missing data	85
4.7.3	Data aggregation and recording interval	89
4.7.4	Variation in instrument types	89
4.7.5	Acquisition and recording of voltage harmonic distortion values	89
4.7.6	Calculation of voltage unbalance	90
4.8	Conclusion	91
<b>Chapter 5: Power Quality Data Analysis &amp; Reporting</b>		<b>92</b>
<b>Techniques</b>		
5.1	Introduction	92
5.2	Analysis considerations	93
5.2.1	Nominal voltage and float voltage	93
5.2.2	Line drop compensation	94
5.3	Initial analysis	94
5.4	Primary indices	95
5.5	Secondary indices	96
5.6	Ranking of sites by monthly index values	99
5.7	Three-monthly ranking of sites and seasonal indices	100
5.7.1	Three-monthly voltage index	102
		<b>Page</b>

5.7.2	Three-monthly voltage unbalance index	102
5.7.3	Three-monthly harmonics index	103
5.8	Ranking of sites on an annual basis	105
5.9	Another voltage index	108
5.10	Conclusions	115
 <b>Chapter 6: Power Quality Data – Factor Analysis</b>		118
6.1	Introduction	118
6.2	Relationship between individual PQ parameters and overall PQ index	119
6.3	Relationship between physical characteristics of sites and overall PQ index	120
6.4	Relationship between physical characteristics of sites and individual primary PQ indices	128
6.4.1	Voltage index	128
6.4.2	Voltage unbalance index	129
6.4.3	Harmonics index	131
6.4.4	Summary of analysis of relationships between site physical characteristics and individual PQ indices	133
6.5	Conclusions from factor analysis of PQ data	134
 <b>Chapter 7: Thesis conclusions and Future Work</b>		136
7.1	Conclusions from research	136
7.2	Future work	140
 Bibliography		143
Appendix A: Additional Power Quality Standards		148
Appendix B: Voltage Distribution Histograms		149
Appendix C: Annual Trend of Utility Voltage Index		152



## List of Figures

<b>Figure</b>		<b>Page</b>
1-1	Common PQ disturbance waveforms	3
2-1	CBEMA equipment immunity curve	20
2-2	ITIC computer equipment immunity curve	21
2-3	3 Level PQ reporting structure	41
3-1	Compatibility levels	49
4-1	Utility PQ network monitoring configuration	80
5-1	Monthly trend of site PQ indices	100
5-2	3-monthly trend of site PQ indices	101
5-3	3-monthly Voltage Index trend	102
5-4	3-monthly Voltage Unbalance trend	102
5-5	3-monthly Harmonics Index trend	103

## List of Tables

<b>Table</b>		<b>Page</b>
1-1	Continuous and discrete disturbances	4
2-1	Utility scorecard with rankings	42
3-1	Compatibility levels for harmonic voltages in LV & MV power systems	60
3-2	Indicative values of planning levels for harmonic voltages in MV power systems	60
3-3	Maximum and 95% values of voltage deviations for monitored sites on the Vector network	63
3-4	Maximum and 95% values of voltage unbalance for monitored sites on the Vector network	64
3-5	Maximum and 95% values of THD for monitored sites on the Vector network	65
4-1	Maximum harmonics measurement errors	79
4-2	Installed PQ meters on the Vector network	82
4-3	PQ meters installed in zone substations on the Vector network	83
4-4	Specifications for ION 7600 and 7700 PQ monitors	84
4-5	61000-4-30 & 61000-4-7 requirements and ION instrument specifications	85
4-6	Main periods of missing data from PQ monitors	86
5-1	Change in Harmonic Index values over the survey period	104
5-2	Annual summary of 15 min site data	107
5-3	Annual summary of daily 95% values	107
5-4	Voltage Deviation Index – data and sample calculation	113
6-1	Correlation coefficients between individual PQ parameters and site overall PQ indices	119
6-2	Correlation coefficients for site physical parameters and annual site PQ index	122
6-3	Correlation coefficients for site category and annual site PQ index	123

<b>Table</b>	<b>Page</b>
6-4 Preparation of data for multivariate linear regression analysis	124
6-5 Results of multivariate linear regression on site physical parameters and PQ index	124
6-6 Results of linear regression analysis between site load category and site PQ index	125
6-7 Preparation of load category data for multivariate linear regression analysis	126
6-8 Results of multivariate linear regression: site load type and PQ index	126
6-9 Correlation between site physical characteristics and annual Voltage Index	129
6-10 Correlation between site physical characteristics and annual Voltage Unbalance Index	130
6-11 Results of multivariate linear regression of site physical characteristics and Voltage Unbalance Index	130
6-12 Results of multivariate linear regression of site physical characteristics and Harmonics Index	131
6-13 Results of multivariate linear regression considering site physical characteristics and Harmonics Index	132
6-14 Results of multivariate linear regression considering site load type and Harmonics Index	133

## List of abbreviations

### Abbreviation

AVD	Absolute Voltage Deviation
CBEMA	Computer and Business Equipment Manufacturers Assoc
CT	Current Transformer
EPRI	Electric Power Research Institute
FFT	Fast Fourier Transform
GXP	Grid Exit Point
HI	Harmonics Index
HoLI	Harmonics outside Limits Index
IEC	International Electrotechnical Commission
IEPQRC	Integral Energy Power Quality & Reliability Centre
ITIC	Information Technology Industry Council
LV	Low voltage (< 1 KV)
MV	Medium voltage (1KV – 35 KV inclusive)
PCC	Point of Common Coupling
PQ	Power quality
PWM	Pulse Width Modulation
rms	Root mean square
THD	Total Harmonic Distortion
UoLI	Unbalance over Limit Index
UoW	University of Wollongong
UPQI	Unified Power Quality Index
VDF	Voltage Distribution Factor
VI	Voltage Index
VoRI	Voltage outside Range Index
VT	Voltage transformer
VUF	Voltage Unbalance Factor
WT	Wavelet Transform

## **Abstract**

Power quality (PQ) has been defined as the study of the sources, effects and control of disturbances that propagate via the electric power supply. The three principal stakeholders in power quality are the electricity user, the electricity supplier and the electrical equipment manufacturer, each of which has a different perspective on power quality.

This thesis looks at power quality primarily from the perspective of the electricity utility. Power quality has traditionally been considered in terms of reliability of supply, and this has been assessed in terms of frequency and duration of interruptions to the supply. However, with the proliferation of electrical equipment that is sensitive to a variety of disturbances in the supply, the reliability of the supply can no longer be defined solely in terms of interruptions. A supply that suffers from disturbance levels that damage or cause misoperation of equipment can be just as expensive and inconvenient to a customer as a supply that suffers from sustained interruptions.

Despite routine power quality monitoring by utilities becoming more common, there is still little standardisation in the methodology for carrying out such surveys. Standard methods for data acquisition, analysing and reporting the data are required. Standardisation is necessary to allow benchmarking of PQ levels between utilities and to allow the determination of typical disturbance levels.

This thesis is an investigation into the practice of routine PQ monitoring by utilities, and in particular the monitoring and reporting of power quality by Vector Ltd (New Zealand). Vector owns and operates the lines network that supplies electricity to most of the Auckland area. Vector has made a significant commitment to PQ monitoring and a large amount of data has been gathered since monitoring began in 1999. The main purpose of this study has been to look at present PQ monitoring and reporting methods at Vector, compare these methods with current industry best practice, and to suggest ways in which these methods could be improved to better meet the needs of Vector.

The focus of this study has been on continuous PQ disturbances (continuous voltage variation, voltage unbalance and harmonic distortion) as opposed to discrete disturbances (voltage sags/swells, transients). Deficiencies in existing analysis techniques have been identified, and an alternative index for voltage variation has been proposed. Methods for deriving seasonal and annual site PQ indices have also been implemented using data from the Vector network covering one full year. Statistical analysis of the data has also been carried out to determine the degree of influence of individual PQ disturbance types on the overall PQ level at a site, and to investigate the influence of each of the known physical characteristics of a site on its power quality performance.

## **Acknowledgements**

My thanks must first go to Vector Ltd for giving me the opportunity to undertake this power quality analysis project, and for allowing me access to power quality data from their network. Within the Vector organisation, special thanks must go to Ashok Parsotam. Ashok has provided on-going assistance, support and feedback throughout the project. He has willingly given up his time to assist me in collating the data, and has provided me with invaluable feedback through his constructive criticism of my work. I hope that in return my this thesis will be of some interest and use to Ashok in his work at Vector.

Elisabeth Sneddon has provided valuable assistance and advice on the statistical analysis of the data.

I would also like to acknowledge the support and assistance of the management of the Electrical and Computer Engineering Department at Manukau Institute of Technology. In particular, John Melrose, Dr Len Jennings and Jim Rodgeron have assisted in providing me with time and resources to complete this project.

Lastly, my thanks go to my academic supervisor Professor Vic Gosbell for his expert guidance and unfailing patience. Associate Professor Sarath Perera has also had significant input into the supervision of this project.