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MASSEY UNIVERSITY
COLLEGE OF SCIENCES

Institute of Food Nutrition and Human Health
College of Sciences, Wellington
New Zealand

**A Field Investigation into the Relationship
between L_{A90} and L_{Aeq} Wind Turbine Sound Level
Descriptors in New Zealand**

A thesis presented in part fulfilment of the requirements for the degree of

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Majoring in

Environmental Acoustics

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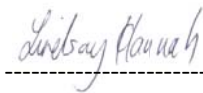
Wellington New Zealand

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December 2011

Certificate of Originality

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Thesis Dedication

This thesis is foremost dedicated to my family, especially my late mother Elizabeth, surrogate mother Katrine, beautiful wife Michaela and daughter Sophie Elizabeth. I would also like to dedicate this thesis to my sister Alison and niece Aerin Elizabeth.

I also dedicate this thesis to everyone who has helped me with my academic studies and acoustic consulting career so far, including those mentioned beneath in the acknowledgements.

Abstract

Wind turbine generator acoustics is an issue for communities as it is people within these communities that occupy dwellings. The current New Zealand wind turbine standard NZS6808:2010 Acoustics – *Wind Farm Noise*, places priority on received sound pressure levels at dwellings remote from the wind turbine rather than from sound emission at the wind turbine generator itself.

As part of assessment under NZS6808:2010, background noise levels are required to be measured [as L_{A90}] at selected relevant receiving locations off site *before* a wind farm site can be developed. Allowable wind turbine design sound limits are then derived [as L_{Aeq}] from a comparison of the *predicted* wind turbine sound pressure levels and the *actual* measured average background noise at the nominated off site receiving location[s].

A disparity arises with the use of two different sound level descriptors used for assessment under the standard, namely the statistical L_{A90} versus the L_{Aeq} energy average sound level descriptors. In order to account for the possible variation between the L_{A90} and L_{Aeq} sound level descriptors NZS6808:2010 requires L_{Aeq} predicted sound pressure levels to be ‘converted’ to received L_{A90} sound pressure levels as part of the acoustic prediction process and hence NZS6808:2010 states the predicted L_{Aeq} sound pressure levels at any receiver location are to be treated as equivalent to the L_{A90} value.

At the time of commencing this study the [then] current New Zealand wind turbine standard NZS6808:1998 Acoustics – *The Assessment and Measurement of Sound from Wind Turbine Generators* stated that background noise levels were ‘typically 1.5 dB to 2.5 dB’ lower than the predicted L_{Aeq} sound pressure levels for wind turbine generator sound.

Unlike the current standard, NZS6808:1998 did not provide any means to account for the disparity between the background noise levels and predicted wind farm sound levels as part of the wind farm assessment process. A key implication being that under NZS6808:1998 wind turbine sound could potentially exceed the allowable 40 dBA design sound limit [or average background noise level + 5 dB] by up to a further 2.5 dB and still remain in compliance with the limits recommended under the NZS6808:1998.

The impetus and motivation behind this study has consequently been to endeavour to quantify the variability between wind turbine generator sound descriptors [L_{Aeq} and L_{A90}] both on the wind farm site and at a remote receiver dwelling location where people actually reside.

The research outcome is relevant as at the time of commencing this thesis NZS6808:1998 was being reviewed by experts and practitioners in the area of wind turbine acoustics. This review included assessing any differences in sound level descriptors.

This review provided the incentive for the thesis being particularly valuable, unique and practical so far as any actual measured field results were relative to wind turbine generators in New Zealand and the New Zealand Standards operating environment.

In order to carry out the evaluation between L_{Aeq} and L_{A90} sound level descriptors an assessment based around a semi-empirical field study of objective field measurements and subjective observations was conducted at two wind farms in the lower North Island of New Zealand. The study assessed present day, commercial class, horizontal, three bladed wind turbine generators located over heterogeneous terrain.

The principal implication of the study related to the collection of uncontaminated wind turbine sound level samples. A raw data set of 11,150 [10 minute L_{Aeq}/L_{A90} sound level samples] were collected over a 12 month period. From the total sample, merely 39 [or less than 2% of the total raw sample] were actual uncontaminated wind turbine sound samples only.

The conclusion here is that due to the high number of intervening variables it is a challenge to collect a large sample set of uncontaminated wind turbine sound data. Based on the data collected, it could potentially take several years to collect a suitable uncontaminated sample of say 1,500 [10 minute samples] from wind turbine sound only at remote locations off the wind farm site using such methods. Data collection and analysis was not an issue on the wind farm site itself due to the measurement location and wind turbine being in close proximity.

The results of the field study illustrated that based on the final data set of 10 minutes sound level sampling [n=39] the overall mean sound level difference [$L_{Aeq} - L_{A90}$] for wind turbine sound was 2.4 dB at a remote residential location some 1200m from the wind farm site. The overall mean sound level difference for wind turbine sound levels based on the wind farm was 1.4 dB [at the nominated R_0 location].

As a result of the study's findings it is concluded that although the field data indicated a quantifiable level difference between the two sound level descriptors the current wind turbine noise standard [NZS6808:2010] rightly removes any uncertainties by stating that $L_{Aeq} = L_{A90}$ when carrying out the assessment process.

Therefore the removal of any uncertainty is chiefly due to the fact that although a quantifiable level difference between the two sound level descriptors was achieved for this study the sound level difference is prone to change and any precise or exact level difference is therefore a factor of the wind turbine generator models tested site conditions and related intervening variables.

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Table of Contents

Certificate of Originality	iii
Reproduction of Work [in Part or Full]	iv
Thesis Dedication.....	v
Abstract	vii
Acknowledgements	ix
Table of Contents.....	xi
List of Figures	xv
List of Tables	xxi
Chapter 1: Introduction and Purpose of the Study	1
Introduction	1
Structure of Thesis	5
Chapter 1: Introduction and Purpose of Study	5
Chapter 2: Wind Turbine Generator Terms and Conventions	5
Chapter 3: Acoustic Terms and Conventions	5
Chapter 4: L_{A90} and L_{Aeq} Sound Level Descriptors in Wind Turbine Acoustics - A Literature Review	5
Chapter 5: Wind Power Generation.....	5
Chapter 6: Aero Acoustics – Wind Turbine Generator Acoustics	6
Chapter 7: A Field Investigation into the Relationship Between L_{A90} and L_{Aeq} Wind Turbine Sound Level Descriptors in New Zealand.....	6
Chapter 8: Discussion.....	7
Chapter 2: Wind Turbine Generator Terms and Conventions.....	9
Introduction	9
The Anatomy of a Wind Turbine Generator	9
Wind Turbine Components and Concepts	14
Chapter 3: Acoustic Terms.....	19
Introduction	19
Objective and Subjective Acoustics - Noise and Sound	19
Acoustic Concepts.....	19
Chapter 4: L_{A90} and L_{Aeq} Sound Level Descriptors in Wind Turbine Acoustics – A Literature Review	39
Introduction	39
Wind Turbine L_{A90} and L_{Aeq} Sound Level Descriptor Studies	40
Research of G.P Van den Berg.....	41
Ramakrishnan Review	44
New Zealand Studies and Reviews.....	46
Wind Turbine Sound Sources.....	48
Aerodynamic Sound from Wind Turbine Generators	52
Navier Stokes Equations	65
Lighthill Theory	65
Low Frequency Sound and Infrasound	66

Annoyance from Wind Turbine Generator Sound	68
Low Frequency Sound and Health Effects from Wind Turbine Generators.....	69
Vibro-Acoustic Disease [VAD].....	73
Wind Turbine Syndrome	75
Impacts of Low Frequency Sound Perceptions and Investigations.....	75
Tonal Sound for Wind Turbine Generators	76
Impulsiveness of Wind Turbine Generator Sound	76
General Spectrum of Wind Turbine Generator Sound.....	77
Vibration.....	79
Seismic Monitoring.....	80
Wind Turbine Generator Acoustic Standards	80
International Standard IEC 61400-11: Wind Turbine Generator Systems Part 11: Acoustic Noise Measurement Techniques - Wind Turbine Sound Power Measurement Standards.	80
NZS6808:1998, Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators and NZS6808:2010 Acoustics Wind Farm Noise	81
Evaluation of NZS6808:2010 Noise Limits versus Noise Limits in Other Countries	83
Chapter 5: Wind Power Generation.....	85
Introduction.....	85
Fundamentals of Wind Power Generation.....	86
The World Wide Development and Evolution of Wind Energy.....	86
Limits on the Wind Capacity.....	90
Chapter 6: Aeroacoustics – Wind Turbine Generator Aerodynamics.....	93
Introduction.....	93
Rotor and Blade Aerodynamics.....	93
Chapter 7: A Field Investigation into the Relationship between L_{A90} and L_{Aeq} Wind Turbine Sound Level Descriptors in New Zealand.....	97
Introduction and Overview	97
Structure of Study	99
Background Information	99
Verbal Description of Test Sites.....	99
Geographic Location and Mapping of Test Sites	100
Wind Turbine Generator Locations	101
Position of Selected Test Turbines and Sound Assessment Locations	104
Photo of Test Sites and Wind Turbine Generators.....	109
Description of Test Wind Turbine Generators.....	113
Technical Specifications of Test Wind Turbine Generators.....	114
Technical Drawings of Test Wind Turbine Generators	115
Test Wind Turbine Generator Sound Power Level [L_{wa}]	116
Assumed Turbine Sound Power Level	117
Measurement Equipment.....	119
Calibration and Specifications of Measuring Equipment used in Study.....	123
Surrounding Environments of Wind Farm Test Sites.....	124
Wind and Climatic Conditions for Test Sites.....	129

Method of Investigation	134
Project West Wind [Makara] Wind Farm	135
Te Apiti Wind Farm	141
Data Filtering and Additional Limitations for Field Work	142
Data Filtering Project West Wind [Makara] Wind Farm [Data Logger]	147
Data Filtering Te Apiti Wind Farm R ₀ Measurement Location [Data Logger]	156
Additional Te Apiti Wind Farm [Handheld Measurements at R ₀ & Base of Turbine] ...	159
Method of Data Analysis.....	161
Results	166
Descriptive Statistical Summary of Results and Observations	175
General Observations.....	175
403 Makara Road – Project West Wind [Makara Wind Farm].....	176
Te Apiti Wind Farm	183
Chapter 8: Discussion	185
Introduction	185
Synopsis of Final Results [Data Set N – 403 Makara Road]	185
Synopsis of Final Results [R ₀ Measurement Position].....	185
Summary Statement of Final Results.....	186
Background to Study.....	187
The Studies Individuality, Innovation and Contribution to Wind Turbine Acoustics in New Zealand.....	190
A Semi-Empirical Study.....	192
Relationship between L _{A90} and L _{Aeq} Sound Level Descriptors	192
Variability of Results	194
Accuracy of Measurement Results	195
Spearman’s and Kendall’s Rank Correlation Coefficients – A Measure of Association between L _{A90} and L _{Aeq}	196
Kendall’s Rank Correlation Coefficient.....	198
Spearman’s Rank Correlation Coefficient	199
Statistical Significance using Spearman’s & Kendall’s Rank Correlation Coefficients...	202
Data Sample Size.....	202
Variability and Data Spread in Results as a Function of Wind Turbine Generator Design, Surrounding Environment and Operating Mode	203
Comparison and Analysis of Sound Level Descriptors [L _{A90} and L _{Aeq}]	209
Comparison and Analysis of Sound Level Meter Measurement Time Weighting and Sample Interval	215
Comparison of Sound Level Meter Signal Processing for L _{A90} & L _{Aeq} Sound Level Descriptors	216
Mechanisms and Intervening Variables Relating to Measured Results.....	219
Measurement Uncertainty	219
Recommendations and Further Work	223
Major Assumptions and Limitations to Body of Work.....	225

Appendix A	A.1
Introduction.....	A.1
Sources of Wind	A.1
Wind Scales.....	A.4
Wind Turbine Generator Available Wind Power.....	A.5
Power Density Function	A.6
Wind Shear and the Increase of Wind Speed with Height	A.7
Wind Speed and Energy Variation with Elevation.....	A.9
Roughness Classes and Roughness Lengths.....	A.10
Topographic Effects on Wind Speeds.....	A.10
Modelled Wind Speed	A.15
Wind Direction	A.16
Wind Speed	A.17
New Zealand Wind Capacity.....	A.17
Aerodynamic Power Control in Wind Turbines Generators.....	A.18
Stall	A.20
Pitch	A.22
Yaw	A.22
Mechanical Power Extracted from Wind	A.23
The Power Co-efficient.....	A.24
Wind Energy Power Output Based on Wind Speed	A.25
Wind Speed versus Power Output	A.28
Sound Power Curve – Wind Speed, Power Output and Sound Power Levels	A.29
Approximate Calculation of Energy Yield from the Wind.....	A.30
Capacity Factor	A.30
Feasible Power Rating	A.31
References.....	A.31
Appendix B	B.1
Introduction.....	B.1
Aerodynamic Lift [Force]	B.1
Torque 2	
Betz’s Elementary Momentum Theory [Disk Actuator Theory]	B.5
Rotor Blade Geometry.....	B.7
Shape	B.7
Number of Rotor Blades	B.8
Two-Bladed [Teetering] Concept.....	B.10
Optimum Rotor Blade Shape.....	B.11
Blade Tip Aerodynamics	B.14
Rotor Blade [Tip] Designs	B.15
Tip Speed Ratio.....	B.16
Tower Aerodynamics.....	B.18
Downwind Wind Turbines Generators.....	B.20
References.....	B.22

List of Figures

Figure 1: Front and side elevation of a three bladed horizontal wind turbine	10
Figure 2: Simple configuration of a Horizontal wind turbine generator.....	11
Figure 3: Photo of modern commercial three bladed horizontal wind turbine generator.	12
Figure 4: Modern commercial three bladed horizontal Nordex wind turbine generator.	13
Figure 5: Mechanical drive system of a wind turbine	14
Figure 6: Common wind turbine generator technologies.....	17
Figure 7: Conceptual diagram of the mechanical-electrical function chain in a wind turbine. .	17
Figure 8: Overview of the electricity generation, transmission and distribution	18
Figure 9: Propagation of a sound wave.	21
Figure 10: Displacement & pressure variation of a pure sound wave [sinusoidal pressure]	22
Figure 11: Octave band based on centre frequency band widths.	26
Figure 12: Third octave band based on centre frequency and widths.	26
Figure 13: Factors moderating potential noise annoyance	27
Figure 14: Schematic of human ear and sound paths.	28
Figure 15: Basic structure of the human ear.	29
Figure 16: Example of threshold of hearing [audibility] for 18 to 25 year old age range.....	30
Figure 17: Example of various time varying acoustical sound level descriptors.....	34
Figure 18: A representation of the radiation of sound from a simple source in free field.....	35
Figure 19: Correction for air attenuation including the inverse square law	36
Figure 20: Approximation of sound fields	37
Figure 21: Location of wind turbines and measurement location [A] for Rhede wind farm near the Dutch/German border	42
Figure 22: Comparison of 48 hour sound measurements levels [L_{Aeq} and L_{A95}]. Measurements presented at 5 min intervals at measurement location A [400m from wind farm]- turbines are considered the dominant sound source from site observations.	43
Figure 23: Comparison of turbine noise statistics	47
Figure 24: Components and total sound power level of a 2MW wind turbine, showing structure-borne [s/b] and airborne [a/b] transmission paths	49
Figure 25: Sample of time varying wind turbine generator [under load] of a modern 3 MW wind turbine [measured at base approx 2 m from generator inside steel tubular base of tower with door closed]	50
Figure 26: Acoustic photograph showing the high speed tips of a wind turbine	55
Figure 27: Sectional elevation through of a typical wind turbine rotor blade and key components. Two dimension sectional view.	56
Figure 28: Flow around a wind turbine rotor blade – three dimension view.....	56
Figure 29: Six mechanisms of aero-acoustic sound	57
Figure 30: Rotor with trailing-edge serrations, including noise sources on rotating blades.	60
Figure 31: Blade tip shape influence on wind turbine sound radiation	62

Figure 32: Distribution of instantaneous values of Powell’s sound source 63

Figure 33: [left] Spectrogram of sound pressure levels measured near a GE 1.5 MW wind turbine generator. [Right]: Spectrogram of sound pressure levels measured near a Vestas 1.8 MW wind turbine generator 64

Figure 34: ISO 7196: 1995 Acoustics – Frequency Weighting Characteristic for Infrasound Measurements G weighting scales 70

Figure 35: Perception threshold of human ear 71

Figure 36: External sound pressure level versus 85 dBG threshold. 72

Figure 37: Frequency distributions within the 1.6 – 500 Hz range, of the A340 cockpit in cruise flight and of a commuter train 74

Figure 38: Low frequency sound from a wind turbine. 1/24 octave band analysis 77

Figure 39: Vestas V52 – 850 kW wind turbine. Typical noise at 10 m/s wind speed 78

Figure 40: Low frequency sound from DAT tape - Bonus 1. 3 MW wind turbine to 200 Hz 78

Figure 41: The relationship between the background noise levels and recommended noise limits set out in NZS6808:2010..... 82

Figure 42: ‘Current’ wind farms development in New Zealand 88

Figure 43: Sample of wind turbine rotor diameter size versus time [1985 to 2007] 89

Figure 44: Sample of wind turbine rotor diameter versus sound power level 89

Figure 45: Basic components of a wind turbine rotor blade and aerofoil cross section..... 95

Figure 46: Basic components of a wind turbine rotor and blades [3d]..... 95

Figure 47: V72/NM72 wind turbine rotor and blades at Te Apiti Wind Farm..... 95

Figure 48: Site location map for Te Apiti and West Wind [Makara] Wind Farms, Lower North Island, New Zealand..... 100

Figure 49: 2D contour map of Project West Wind [Makara] Wind Farm, 403 Makara Road and D12 Wind Turbine Generator.101

Figure 50: 2D aerial photo of Project West Wind [Makara] Wind Farm, showing 403 Makara Road and closest wind turbine generators with access tracks. Drawing adapted from Google Earth to include turbines..... 102

Figure 51: Black and white 2d aerial photo with Te Apiti Wind Farm, including Tap 44 wind turbine generator and tracks..... 103

Figure 52: 3D aerial representation with Te Apiti Wind Farm overlay, including Tap 44 wind turbine generator & R₀ measurement location. Note undulating terrain. Drawing adapted from Google Earth to include turbines..... 103

Figure 53: Illustration of the definitions of R₀ and slant distance R₁ [..... 104

Figure 54: 2d base aerial photo with Te Apiti Wind Farm Tap 44 wind turbine generator [protruding 3d] and R₀ measurement location. 105

Figure 55: 3d aerial photo with Te Apiti Wind Farm Tap 44 wind turbine generator and R₀ measurement location. 105

Figure 56: 3D schematic of 403 Makara Road location relevant to D12 wind turbine generator. Note steep surrounding terrain and hills. Drawing adapted from Google Earth to include 403 Makara Road and D12.	107
Figure 57: 3D aerial photo of Project West Wind [Makara] Wind Farm, showing 403 Makara Road and closest wind turbine generators with access tracks. Drawing adapted from Google Earth to include 403 Makara Road and D12.....	108
Figure 58: Visualization of D12 wind turbine blades as viewed from 403 Makara Road	108
Figure 59: Te Apiti Wind farm as viewed from off the wind farm site, looking east-ward towards farm.....	109
Figure 60: Photo simulation as viewed from base of Tap 44 360 degree view.	109
Figure 61: Photo viewed from base of Tap 44 looking approx north-west towards turbine Tap 26 in foreground.	109
Figure 62: Photo viewed from base of Tap 44 looking approx north towards turbine Tap 45 in foreground.	110
Figure 63: Photo viewed from base of Tap 44 looking approx south. Note fence line represents wind farm site boundary with steep drop off terrain towards Manawatu Gorge below.	110
Figure 64: Photo viewed from base of Tap 44 looking approx west, turbines in far background from Tauraua Wind Farm [along ridge line].....	111
Figure 65: Photo viewed from approx north-west looking towards base of Tap 44.	111
Figure 66: Photo viewed from approx south west looking towards base of Tap 44. Tap 45 in foreground.	112
Figure 67: Photo viewed from approx south east looking towards base of Tap 44. Tap 26 in foreground.	112
Figure 68: Photo viewed from aircraft of West Wind, Wind Farm.	113
Figure 69: Technical drawing of front and side elevations of Vestas V72 Wind Turbine Generator including key dimensions and photo.....	115
Figure 70: Technical drawing of front and side elevations of Siemens SWT 2.3-82V Wind Turbine Generator including key dimensions and photo.	115
Figure 71: Graph of Sound Power Level for Vestas V72 wind turbine generator at various frequencies [standard and setting 4 sound powers operating modes provided].	118
Figure 72: Graph of Measured Sound Power Level for Vestas V72 wind turbine generator at various frequencies for 8 m/s operating speed [standard sound power operating mode provided].	119
Figure 73: 2260 Bruel and Kjaer Integrating Sound Level Meter and calibrator and wind screens.	120
Figure 74: M-Audio Micro Track II and related equipment used in study.....	120
Figure 75: Garmin GPS Unit.	121
Figure 76: Garmin GPS Unit at base of Tap 44, Te Apiti Wind Farm.....	121
Figure 77: Garmin GPS Unit Software and tracking GPS points.....	122

Figure 78: Heavy duty pelican case used in study for weather protection of measurement apparatus	123
Figure 79: 2D map with Te Apiti Wind Farm and wider surrounding environment [including existing and proposed wind farm developments]	126
Figure 80: 3D colour schematic of 403 Makara Road location relevant to D12 wind turbine generator.	128
Figure 81: NIWA median annual average wind speed map for New Zealand.....	130
Figure 82: Sample Wind Rose for Makara area – All wind directions	131
Figure 83: Sample wind rose for Makara area – All wind directions	132
Figure 84: Sample wind rose for Makara area – [Left] Night time [Right] Day time wind directions	132
Figure 85: Sample wind rose for Te Apiti – All wind directions	133
Figure 86: Schematic flow diagram of set up for field measurement testing of sound pressure levels and audio recording.....	137
Figure 87: Schematic flow diagram of set up for field measurement testing of sound pressure levels.....	140
Figure 88: Graph of measured sound pressure levels with equipment failure of microphone versus time.	143
Figure 89: Graphic of rain radar from New Zealand Met Service.....	145
Figure 90: Graphic of weather data for 24 hour period from weatherunderground.com	145
Figure 91: Graph of filters applied to measured sound pressure levels and number of raw samples	148
Figure 92: Scatter graph with second order polynomial curve of measured 10 minute sound pressure levels versus measured wind speed at V_{10m} and $V_{Hub\ Height}$	152
Figure 93: Graph of expected wind farm sound pressure levels only versus actual measured wind farm and wind farm plus background sound pressure levels.....	153
Figure 94: Graph of fundamental relationship between wind speed levels at $V=10\ m$ and Beaufort Scale Number [Land scale]	155
Figure 95: Graph of measured wind turbine & background sounds versus time, levels presented as L_{Aeq}	158
Figure 96: Schematic of a low signal to noise ratio illustrating an obtrusively high background noise level masking a desired sound signal from the wind turbine sounds.....	163
Figure 97: Schematic of a preferred signal to noise ratio illustrating a high signal from the wind turbine above masking signals from background noise levels.	163
Figure 98: Flow chart of method.	165
Figure 99: Graph of R^2 values L_{Aeq} versus L_{A90} . 403 Makara Road, 10 minutes Sampling Time, Data Sets B to N	170
Figure 100: Graph of R^2 values L_{Aeq} / L_{A90} versus wind speed [$V=_{Hub\ height}$].	170
Figure 101: Graph of actual measured time varying sound pressure level of L_{A90} vs wind speed and expected wind farm sound level only.....	171

Figure 102: Graph of actual measured time varying sound pressure level of L_{Aeq} vs wind speed and expected wind farm sound level only [expressed as best fit line [log function].	172
Figure 103: Graph of calculated expected wind farm sound pressure level only expressed as L_{Aeq} and L_{A90} vs wind speed 403 Makara Road.	173
Figure 104: Graph of calculated expected wind farm sound pressure level only expressed as L_{Aeq} and L_{A90} vs wind speed 403 Makara Road	173
Figure 105: Graph of calculated expected wind farm sound pressure level only expressed as L_{Aeq} and L_{A90} vs wind speed 403 Makara Road	174
Figure 106: Graph of historic measured time varying sound pressure level of L_{Aeq} and L_{A90} . Date of sample 23 June 1997 to 14 August 1997 [22 days].	175
Figure 107: Graphic of mean level sound level differences for 403 Makara Road and Te Apiti Wind Farm.	186
Figure 108: Example of a direct positive relationship between L_{Aeq} or L_{A90} sound descriptors where the arrows represent an increase or decrease in sound levels.	193
Figure 109: Example of a direct negative relationship between L_{Aeq} or L_{A90} sound descriptors where the arrows represent an increase or decrease in sound levels.	193
Figure 111: Scatter graph of rank [Data Set M] Spearman Rank Correlation Coefficient.	200
Figure 112: Scatter graph of rank [Data Set N] Spearman Rank Correlation Coefficient.	200
Figure 113: Scatter graph of L_{A90} versus L_{Aeq} for Data Set B.	204
Figure 114: Scatter graph of L_{A90} versus L_{Aeq} for Data Set M.	204
Figure 115: Scatter graph of L_{A90} versus L_{Aeq} for Data Set N.	205
Figure 116: Scatter graph of L_{Aeq} [redline, with red dots] and L_{A90} [blue line with blue dots] versus wind speed at hub height [m/s] for Data Set B	205
Figure 117: Scatter graph of L_{Aeq} [redline, with red dots] and L_{A90} [black line with blue dots] versus wind speed at hub height [m/s] for Data Set M	206
Figure 118: Scatter graph of L_{Aeq} [redline, with red dots] and L_{A90} [black line with blue dots] versus wind speed at hub height [m/s] for Data Set N.	206
Figure 119: [Top] 2d [Bottom] 3d - Prediction of sound pressure level for 403 Makara Road Contours of equal sound pressure levels between L_{Aeq} 35 and 50 dB.	208
Figure 120: Graph of measured instantaneous time varying sound pressure level for 30 second measurement period with the same L_{Aeq} sound level	210
Figure 121: Graph of measured instantaneous time varying sound pressure level and noise descriptor relationships.	211
Figure 122: Graph of measured instantaneous time varying sound pressure level from non-filtered raw data [L_{Aeq} and L_{A90}] at 403 Makara Road.	212
Figure 123: Time varying graph L_{A95} dB Sample A.	213
Figure 124: Time varying graph L_{A95} dB Sample B.	213
Figure 125: Time varying graph L_{A95} dB Sample C.	214
Figure 126: Time varying graph L_{A95} dB Sample D.	214
Figure 127: Time varying graph L_{A95} Sample E.	215

Figure 128: Percentile levels..... 218
Figure 129: Sound level distribution curves. 219
Figure 130: Example of noise floor in study measurements. 222
Figure 131: Bruel and Kjaer Pulse System 224

List of Tables

Table 1: Noise annoyance moderators	27
Table 2: Aero acoustic mechanisms of a wind turbine generator	53
Table 3: Frequency ranges covered and method of exposure from seven studies.....	67
Table 4: Comparison of dBA and dB _{Lin} values in several low Frequency environments.....	74
Table 5: Relationship between the background noise levels and recommended noise limits set out in NZS6808:2010.....	83
Table 6: Wind farm noise limits set in other countries	84
Table 7: Te Apiti Wind Farm, Tap 44 Wind Turbine Generator New Zealand Map Grid Northing Northing & Easting coodinates, Ro assessment location heights & distances.....	106
Table 8: Project West Wind, Wind Farm, D12 Wind Turbine Generator & 40 Makra Road New Zealand Map Grid Northing and Easting co-ordinates, heights and distances. ...	107
Table 9: Table of generic specifications for test turbines - Vestas V72 and Siemens SWT 2.3-82V wind turbine generator.....	114
Table 10: Measured Apparent Sound Power Level for Vestas V72 Wind Turbine Generator..	117
Table 11: Measured Apparent Sound Power Level for Siemens SWT 2.3-82V	117
Table 12: Measured <i>Apparent Sound Power Level</i> for Vestas V72	117
Table 13: Measured Apparent Sound Power Level for Vestas V72.	118
Table 14: Description of key sound level measuring apparatus used in study.....	119
Table 15: Description of audio level measuring apparatus used in study.	120
Table 16: Description of key handheld weather apparatus used in Study.	121
Table 17: Description of GPS apparatus used in study.	121
Table 18: Description of various supplementary apparatus used in study.	123
Table 19: Description of filters applied to measured sound pressure levels and number of raw samples.	147
Table 20: Statistical table of measured time varying sound pressure level of L _{Aeq} and L _{A90} . 403 Makara Road. 10 minutes Sampling Time. Data Set M.....	166
Table 21: Statistical table of measured time varying sound pressure level of L _{Aeq} and L _{A90} . 403 Makara Road. 10 minutes Sampling Time. Data Set N.....	166
Table 22: Statistical table of measured time varying sound pressure level of L _{Aeq} and L _{A90} at wind speeds 4 to 10 m/s. 403 Makara Road.....	167
Table 23: Summary statistical table of measured time varying sound pressure level of L _{Aeq} and L _{A90} . 403 Makara Road. 10 minutes Sampling Time. Data Sets B to L.....	169
Table 24: Summary statistical table of R ² values L _{Aeq} versus L _{A90} versus wind speed [V= _{Hub height}] 403 Makara Road. 10 minutes Sampling Time. Data Sets B to N.....	169
Table 25: Summary table of actual measured time varying sound pressure level of L _{A90} vs wind speed and expected wind farm sound level only [expressed as best fit line [log function]. 403 Makara Road.....	171

Table 26: Summary table of actual measured time varying sound pressure level of L_{Aeq} vs wind speed & expected wind farm sound level only [expressed as best fit line 172

Table 27: Summary table of calculated expected wind farm sound pressure level only expressed as L_{Aeq} and L_{A90} vs wind speed 403 Makara Road 174

Table 28: Statistical table of measured time varying sound pressure level of L_{Aeq} and L_{A90} . 403 Makara Road. 10 minutes sampling time. Data Set N 185

Table 29: Statistical table of measured time varying sound pressure level of L_{Aeq} and L_{A90} . Te Apiti Wind Farm Tap 44 – R_o measurement location and base of wind turbine generator. Sampling time as shown. 185

Table 30: Calculated Spearman Rank Correlation Coefficient [SRCC] and Kendall tau Rank Correlation Coefficient [KRCC] for all data [Data Set B], Data Set M & Data Set N 199

Table 31: Examples from *IEC 61400-11: Wind Turbine Generator Systems Part 11: Acoustic Noise Measurement Techniques* of possible values of uncertainty components relevant for apparent sound power level measurements 220

Table 32: Inherent noise level of 2260 Bruel and Kjaer Sound Level Meter 221