

BEFORE THE BOARD OF INQUIRY

IN THE MATTER of the Resource
Management Act 1991

AND

IN THE MATTER of applications for resource
consent and notices of
requirement by Transpower
New Zealand Limited for the
North Island Grid Upgrade
Project

**STATEMENT OF EVIDENCE OF NIGEL ROBERT LLOYD FOR TRANSPOWER
NEW ZEALAND LIMITED
(Noise review and conditions)**

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QUALIFICATIONS AND EXPERIENCE

1. **MY** name is Nigel Robert Lloyd. I have been an acoustic consultant with Acousafe Consulting & Engineering Ltd since 1985. I hold a degree in Mechanical Engineering from the University of Wales received in 1976.
2. **MY** previous work experience includes five years as the noise control engineer with the New Zealand Department of Labour and three years with the Industrial Acoustics Company in the United Kingdom. Including my time spent with Acousafe as an acoustical consultant this is a total of thirty years direct involvement with noise control and acoustical related work.
3. I confirm that I have read and am familiar with the Code of Conduct for Expert Witnesses in the Environment Court Consolidated Practice Note (2006). I have approached the preparation of this evidence in the same way that I would for the Environment Court.
4. **IN** relation to Clause 5.3.1 (c) of the Code of Conduct, I advise that I am relying to the extent described below, on the expert knowledge of Dr Constantin Wassilieff, who is the manager of the Wellington office of Marshall Day Acoustics Limited. He has a Doctorate of Philosophy degree in Physics from Victoria University of Wellington and has worked in the field of acoustics, noise measurement and assessment, and noise control engineering since 1980.
5. I note that Graham Warren also relies on the expertise of Dr Wassilieff in the preparation of his evidence presented to this Board of Inquiry and to that extent I also rely on the expertise of Graham Warren in respect of the noise predictions that have been undertaken for the various sub stations and for the overhead line sections.

Introduction

6. I have been engaged by Transpower New Zealand Limited (**Transpower**) to consider the evidence of Graham Warren and to assist the Board of Inquiry by recommending Draft Noise Conditions in the event that the Board should decide to consent to the Notices of Requirement (**NOR**) for the North Island Grid Upgrade Project (**Upgrade Project**).

7. I became involved with the Upgrade Project in October 2007. I have read the noise assessments for Otahuhu and Pakuaranga Substations and I have read the noise assessment for the proposed Brownhill Road Substation. I visited these three sites on 15 October 2007 in the company of Mr Deller, Transpower's substation asset development team leader, and with Dr Wassilieff, among others.
8. I have not visited Whakamaru as part of this project but previously undertook measurements of all of the Hydroelectric Power Stations in the Waikato River catchment area when they were owned by ECNZ. This included Whakamaru.
9. I have read the assessments for noise for the proposed overhead lines between Brownhill Road and Whakamaru. I have not toured the approximately 186km of this route.
10. I have read the documents prepared for the NORs relevant to the area of noise and I am aware that Transpower's objectives are to internalise adverse environmental effects as part of the designation process for this project.
11. **IN** his evidence Mr Warren sets out the relevant documents pertinent to the noise assessments and I confirm that I have read that information.

Scope of evidence

12. **IN** my evidence I recommend draft noise conditions for the following:
 - (a) the overhead transmission line, and associated effects;
 - (b) substation noise;
 - (c) construction noise:
 - (i) overhead lines;
 - (ii) substation development; and
 - (iii) underground cable construction (construction noise only).

13. I explain the reasoning behind my recommended Draft Conditions which are mostly based on the Suggested Conditions in the relevant parts of the NOR. However where my recommended Draft Conditions differ from those in the NOR then I explain the reasons for this.
14. **MY** evidence also demonstrates why the Draft Noise Conditions will appropriately protect the health and amenity values of those people and communities situated proximate to the overhead transmission lines and to the substations.
15. **IN** my evidence I deal solely with the generation of acoustical sounds and the control of acoustical noise (defined as unwanted sound). I refer to sounds associated with the operation of electrical equipment. These sounds are acoustical sounds and should not be confused with electrical noise (such as might interfere with television or radio reception).

Philosophy

16. **AS** with many designation projects of this magnitude much of the detailed design work is still to be done.
17. **THE** Pakaranga Substation will be rebuilt by 2011 to allow 220kV from Brownhill to be transformed to 33kV. This replacement Substation is proposed to be constructed on land immediately adjacent to the existing Substation which will then become redundant and will be removed.
18. **THE** initial detailed design for Brownhill Substation will be for a transition station from overhead to underground cabling which will not involve equipment that generates significant noise. The full Substation Development at the new Brownhill Substation is projected to take place in the year 2033, when eventually there will be a need to fully upgrade to the 400kV system. Up until that time Brownhill will only be a transition point. Technology is likely to have improved between now and 2033 and the potential exists for quieter technology to be available when the detailed design work takes place for these transformers.
19. **IT** is still important though that it be demonstrated what noise emissions are likely to be with the current state of technology and set limits accordingly, but it should be

recognised that technological improvements should make it easier to contain noise in the future.

20. **BECAUSE** Transpower's objectives are to internalise adverse effects where practicable then I will set out to recommend Draft Noise Conditions in **Appendix A** that will appropriately protect neighbouring residential amenity values. Subject to specific circumstances, the most appropriate place to do this in a project of this type is to establish noise limits principally just beyond the boundary of the Designation areas sought. This ensures consistency and certainty, rather than the use of notional boundaries which could change depending on matters beyond Transpower's control.

21. **FOR** the Brownhill Substation I recommend Draft Conditions that apply the maximum recommended noise limits found in NZS6802:1991 at the designation boundary combined with limits equivalent to those in the District Plan which apply at the notional boundaries of existing dwellings. The maximum recommended guidelines in NZS6802:1991 are:

Nighttime	45dBA L_{10} , and an L_{max} of the lower of 75dBA or the background sound level plus 30
Daytime	55dBA L_{10}

22. I believe that where the installation of noise generating equipment will not take place for approximately 25 years then it is important to provide some certainty in respect of constraining the noise at the designation boundary to protect residential developments that may occur in the interim. I understand that Transpower would need to reduce noise emissions to below those predicted in Graham Warren's evidence to achieve the designation boundary limits that I am recommending but there are potential additional noise mitigation measures available to achieve this.

23. **THE** topography of the land near to this designation restricts residential development on land that is likely to be most exposed to transformer noise, making the combination of the designation and notional boundary limits appropriate.

24. I also recommend refinements to the noise restriction proposed in the NOR for Otahuhu Substation. The restraints proposed in the NOR rely on the existing noise levels that are being generated at residential boundaries. These exceed the

maximum recommended guidelines set out by New Zealand Standards, particularly at nighttime.

25. **IN** my recommended Draft Conditions I allow for future installations of electrical equipment to be controlled to noise levels significantly below the existing noise levels on the basis that, as noisier equipment is progressively treated and/or replaced, overall sound emissions will be reduced. Despite the generally high noise levels in the vicinity, as existing noise levels from the substation are greater than desirable, then Transpower will progressively review the reduction of noise and report any progress to Manukau City Council at the time of the designation roll-over. The replacement of transformers where necessary will progressively allow these existing noise levels to be reduced.

Assessment criteria

26. **NOISE** criteria are recommended by the World Health Organisation (**WHO**) and by New Zealand Standards. An extract from a current WHO Fact Sheet No.258 Revised February 2001 is as follows:

WHO has responded in two main ways: by developing and promoting the concept of noise management, and by drawing up community noise guidelines. The field is marked by a scarcity of literature, especially for developing countries. Some 20 years after its last publication on noise, WHO has issued Guidelines for Community Noise. This publication, the outcome of a WHO expert task force meeting in London in March 1999, includes guideline values for community noise (listing also critical health effects ranging from annoyance to hearing impairment), for example: (ref Guidelines p. XVIII)

Environment	Critical health effect	Sound level dB(A)*	Time hours
Outdoor living areas	Annoyance	50 - 55	16
Indoor dwellings	Speech intelligibility	35	16
Bedrooms	Sleep disturbance	30	8
School classrooms	Disturbance of communication	35	During class

**The ear has different sensitivities to different frequencies, being least sensitive to extremely high and extremely low frequencies. (ref Fundamentals of Acoustics p.19) Because of this varied sensitivity, the term "A weighting" is used: all the different frequencies, that make up the sound, are assessed to give a sound pressure level. The sound pressure level measured in dB is referred to as "A-weighted" and expressed as dB(A). (ref Guidelines p.IX and X).*

27. **THE** provision of an internal sound level of 30dBA requires that outdoor levels have to be less than about 45dBA to reduce noise while allowing windows to be kept open sufficiently for ventilation to occur.
28. **WITH** respect to the generation and transmission of electricity, this typically takes place on a 24 hour per day basis and therefore the nighttime sleep disturbance mechanism becomes the controlling factor.
29. **THE** New Zealand Standards for the measurement and assessment of environmental noise NZS6801 and NZS6802 are presently under revision. Reference is still made to the 1991 version of the Standards because there are inconsistencies present in the 1999 versions.
30. **NZS6802:1991** provides for an adjustment to be made to the performance standards when noise has special audible characteristics. Special audible characteristics include sounds that exhibit tones and such tonal sounds are regularly encountered with electricity generation. The tonal sounds that are heard are commonly the 100Hz harmonic of the 50Hz alternating current frequency. This is the "hum" that may be heard when standing near to large transformers.
31. **THE** documentation in the NOR recognises that a 5dB penalty will need to be introduced when mains hum is present and states that to comply with the proposed limits then the actual noise levels will need to be 5dB lower than the set limit. Therefore if the limit is, say, 45dBA, then the noise emission will need to be less than 40dBA at the point of assessment. Care must be taken so that the penalty is not pre-empted as part of establishing the noise limit otherwise there is a danger of the penalty being applied twice (e.g. when the noise limit is set and also when the noise levels are measured and assessed). The draft noise limits I recommend therefore are not initially influenced by the fact that the equipment noise may be tonal in

character but would be subject to the 5dB penalty should tonality be present at the time of assessment.

32. **LOW** frequency noise is associated with the operation of large transformers and this can present difficulties on two fronts:
- (a) wooden buildings with dry wall (Gib) linings do not readily insulate against low frequency noise;
 - (b) the A-weighting scale that is used in measurement devices to determine dBA does not always fairly assess noise with low frequency characteristics; and
 - (c) a small percentage of the population is bothered by low frequency sounds that are sometimes difficult to place.
33. **DIFFICULTIES** with low frequency noise are unlikely to occur at Otahuhu Substation because there are already a significant number of older transformers in action and no complaints have been received from neighbours. Similarly at Pakuranga residents have moved to the area with knowledge that there is already a significant transformer substation at this location. When transformers are eventually installed at Brownhill (projected to be 2033) then it would be expected that their design will reduce low frequency noise transmission to a minimum.
34. **FURTHER** investigation would be undertaken by Transpower if there was to be an isolated case where a resident was bothered by the noise even if the basic noise conditions were met. This investigation would identify the source of the noise and instigate the best practicable option to control that noise.
35. **LOW** frequency noise emissions should not be an issue with the overhead line section. Any sounds of concern are likely to be for reasons other than the influence of the alternating current frequency, and low frequency sounds should be not be significant.

Recommended Draft Conditions

36. **MY** recommended draft conditions are set out in detail in **Appendix A**. These conditions do not address vibration issues, as these are addressed satisfactorily in Mr Warren's evidence.

Construction noise

37. **CONSTRUCTION** noise must be controlled for each part of the project and NZS6803:1999 Acoustics – Construction Noise has been referred to. Exemptions are provided for emergency work that may be required (particularly at night) to re-establish continuity of supply, on the basis that noise will be controlled by adopting the best practicable option at such times.
38. **MAJOR** construction and maintenance works will be undertaken in accordance with a formal noise management plan written specifically for the task. Reference is made to NZS6803:1999 which I believe contains all of the ingredients for a suitable noise management plan for construction works.

Pakuranga Substation

39. **THE** Proposed Restriction on Page 44 of Part III of the NOR Documentations is as follows:
- (a) Noise limit at the Boundary of the Designation - 40dBA (allowing for 5dB penalty) 7am – 10pm;
 - (b) Noise limit at the Boundary of the Designation - 30dBA (allowing for 5dB penalty) 10am – 7pm; and
 - (c) The above limits apply on all days of the year.
40. **ANY** noise generated by construction activities will not exceed the limits specified in New Zealand Standard 6803:1999 Acoustics Construction Work.
41. **THESE** have been adapted as Draft Conditions in **Appendix A** and the numerical values of the Proposed Restrictions have been increased by 5dB to allow the penalty

for special audible characteristics (should one exist) to be applied by reference to NZS6802:1991. For the reasons I set out earlier, this does not in fact change the limit from what is proposed in the NOR. It simply expresses it in a different and, in my opinion, a slightly clearer way.

42. **THE** noise limits are applied at the residentially zoned sites beyond the designation boundary. I have considered applying the noise limits at the designation boundary but the difficulty with this is that the Condition can be subverted if a noise screen is placed on the boundary itself. The noise limits need to be met at locations beyond the boundary and I believe that the wording I have selected achieves this aim.
43. **THE** levels are established as L_{10} with a nighttime L_{max} noise limit of 70dBA.
44. **THE** L_{10} is the sound level that is equalled or exceeded for ten percent of the time while the L_{max} is the maximum sound level in any measurement time frame. The L_{max} control would be relevant to controlling the noise of electrical circuit breakers.
45. **THE** studies undertaken by Maunsell/AECOM Ltd show that this is a relatively noisy area and, given that there is an existing substation at the site, then compliance with the recommended noise limits will ensure that noise will not cause any additional impacts on neighbours.

Otahuhu Substation

46. **THERE** is a major substation already at Otahuhu which is zoned Business 5 in the Manukau District Plan. The existing sound emissions are a complicating factor in that there are already noise emissions from the site that are predicted to be greater than would normally be acceptable. Marshall Day has measured and predicted the noise contours and these show a sound level of 54dBA at the Substation Boundary and 52dBA at the nearest residential section being the corner of No.8 Waipapa Crescent. These sounds contain special audible characteristics and a 5dB penalty would apply in the assessment process.
47. **THE** complexity of writing Conditions for Otahuhu is to control noise from the designated site, but at the same time to recognise the existing status of the Substation. Ordinarily it would not be practical to establish new noise limits that are more stringent than the levels that already exist and for which an existing use has

been established. However Transpower will be in a position to progressively reduce noise as existing transformers are replaced, where necessary, and this process will be reviewed and reported to Manukau City Council as part of the designation roll-over.

48. **BECAUSE** it will not be possible to undertake simple noise checks to confirm that the stricter noise limits have been complied with, there will need to be a transparent system of reporting of the design process, installation, and sound power measurements. These are provided for in the Draft Conditions.

Brownhill Substation

49. The noise limits in the Manukau City District Plan for the Rural Area are strict. The limits are:

Monday – Saturday 6am -6pm 45dBA L₁₀

Monday to Saturday 6pm-10pm 40dBA L₁₀

All other times 35dBA L₁₀

L_{max} - 9pm-6am - 65dBA or the background plus 30dBA (whichever is the lower)

50. **THE** NOR proposes to apply notional boundary limits to meet the Whitford A Zone noise rules in the District Plan and also to apply the *Flat Bush Countryside Transition Zone* limits at that Zone boundary. The notional boundary is a line 20 metres from the façade of a dwelling or the legal boundary if that is closer to the dwelling.
51. **IT** is Transpower's intention to internalise the adverse noise effects as far as is reasonably practicable. I propose therefore that the strict District Plan noise limits apply at the notional boundaries of existing dwellings and that, in addition, standards apply at the designation boundary.
52. **THE** limits that I recommend for the designation boundary are the maximum levels recommended by NZS6802:1991 for the reasonable protection of community health and amenity (Section 4.2.2). These will then protect future dwellings likely to be developed closer to the designation. The topography of the surrounding land will provide additional buffering to future residential development that will ensure noise levels will be even lower than that allowed at the designation boundary.

53. **THE** application of these standards would ensure that no significant adverse noise effects would result from these works.

Underground cables

54. **THERE** will be no operational noise issues with the underground cables and noise conditions are therefore limited to control of construction noise using NZS6803:1999.

Overhead line section

55. **SOUND** associated with the overhead line section includes electrical (corona) discharge sound and wind sounds in the tower structure and from the cables.
56. **CORONA** discharge occurs only on the insulators at the towers and mainly when the insulators are wet due to rain or fog.
57. **THE** suggested noise restriction in the NOR is for noise *"not to exceed L_{Aeq} 40dB at any time at the edge of the designation area (or easement boundary), for the operational stage"*.
58. **THE** evidence of Graham Warren and work done by Dr Wassillief shows that this noise limit will be complied with.
59. **THE** limit of L_{Aeq} 40dB is a reasonable nighttime limit to be applied at the designation boundary given that dwellings will be further from the noise source. I understand that there are 36 dwellings located within 100 metres of the designation boundary.
60. **THERE** are no schools close enough to the designation to be impacted upon by noise.
61. **TIMES** when the maximum sound emissions are likely to occur from the overhead line section are times of fog and rain or high winds when outside amenity levels will be poor. A limit of less than L_{Aeq} 40dB will ensure that a high level of daytime amenity is preserved and will provide good protection against nighttime sleep disturbance.

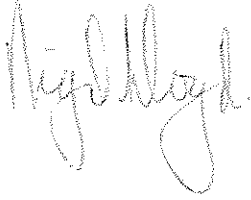
Whakamaru Substation

62. **THE** proposed restriction for Whakamaru Substation in the NOR is “*Not to exceed 40dBA L_{eq} at any time at the designation boundary, for the operational stage*”. This restriction is based on L_{eq} rather than L_{10} with L_{eq} being the unit of choice in the Taupo District Plan. Because of problems with the 1999 versions of the New Zealand Standards which prevent a consistent approach being applied to the measurement and assessment of environmental noise, I propose to set these conditions principally as L_{10} . I use L_{eq} in the case of Whakamaru because the Taupo District Plan uses this metric and also with the overhead transmission lines. This is because noise from the transmission lines has been calculated using L_{eq} . Measurement and assessment will be undertaken in accordance with NZS6801:1991 and NZS6802:1991. There is no significant difference to the assessment of steady sound between measurement using L_{eq} and L_{10} . The L_{eq} is the equivalent continuous sound level or the energy average of the sounds as they vary over time.

Conclusions

63. **THE** NORs provide for the designation of land that will allow the establishment of overhead and underground electricity transmission lines and associated facilities from Whakamaru to Pakuranga and Otahuhu Substations.
64. I attach a set of Draft Noise Conditions (**Appendix A**) that I believe will appropriately control noise from each aspect of the proposed Upgrade Project. I have consulted with Mr Warren regarding these conditions.
65. **THE** Notices of Requirement seek to designate Otahuhu Substation and Pakuranga Substation neither of which are presently designated. My recommended Draft Noise Conditions also provide for ongoing reviews of existing noise at Otahuhu and for the progressive noise reduction. The existing transformer substation at Pakuranga will be replaced by new transformers as part of the Grid Upgrade project.
66. **THE** recommended Draft Noise Conditions are designed to control noise principally beyond the designation boundaries thus seeking to internalise adverse noise effects. The Conditions also recognise the local District Plan noise limits but are written to offer consistency to existing residents and local communities and to provide certainty

as to what the outcomes will be over the approximately 25 years that will be needed to complete the Upgrade Project.

A handwritten signature in black ink, appearing to read 'Nigel Lloyd', with a stylized, cursive script.

Nigel Robert Lloyd

1 February 2008

REFERENCES

1. WHO Fact Sheet No.258 Revised February 2001
<http://www.who.int/mediacentre/factsheets/fs258/en/>.
2. Berglund & Lindvall (1995) "Community Noise", World Health Organisation, Archives of the Centre for Sensory Research, Vol 2 Issue 1, 1995.
3. NZS6801:1991 Measurement of Sound, NZS6802:1991 Assessment of Environmental Sound, NZS6801:1999 Acoustics – Measurement of Environmental Sound, NZS6802:1999 Acoustics – Assessment of Environmental Sound.
4. NZS6803:1999 Acoustics – Construction Noise.

APPENDIX A
TRANSPower NEW ZEALAND LIMITED
NORTH ISLAND GRID PROJECT

Recommended Draft Noise Conditions

Construction Noise

[The following Conditions (1-3 inclusive) are recommended to deal with the construction noise aspects of each part of the Notice of Requirement]

1. **ALL** construction and maintenance work shall be designed, managed and conducted to ensure that construction and maintenance noise from the site does not exceed the limits in NZS6803:1999 Acoustics – Construction Noise at locations set out in Section 6.2 of that Standard.
2. **THE** noise limits shall not apply to emergency work required to re-establish continuity of supply but all practicable steps shall be undertaken to control noise and to avoid adverse noise effects particularly at times when the stricter noise limits apply (e.g. at nighttime).
3. **PRIOR** to any significant construction work taking place, including any earthworks, a formal noise management plan shall be prepared, with the assistance of a suitably qualified and experience person, that sets out the management procedures in terms of Section 8 and Annex E of NZS6803:1999 and the works shall be undertaken in accordance with that noise management plan.

Pakuranga Substation

4. **ALL** activities within the designation (except for construction and maintenance) shall be designed and operated to ensure that the following noise limits shall not be exceeded at or within the boundary of any residentially zoned site:

All days	7.00am to 10pm	45dBA L ₁₀
All nights	10pm to 7am	35dBA L ₁₀
All nights	10pm to 7am	70dBA L _{max}

5. **SOUND** levels shall be measured and assessed in accordance with NZS6801:1991 Measurement of Sound and NZS6802:1991 Assessment of Environmental Sound.
6. **SOUND** monitoring shall be undertaken by a suitably qualified and experienced person within one month of the commissioning of any new transformer. The results of the noise monitoring shall be made available to the Manukau City Council upon request.

Otahuhu Substation

7. **THE** existing noise levels at the Otahuhu Substation (except for construction and maintenance works) have been predicted as 52dBA L_{10} at Nos. 8, 12 and 16 Waipapa Crescent. These sound levels contain special audible characteristics and an assessment using NZS6802:1991 would cause any performance standard to be reduced by 5dB.

8. **ANY** new equipment (such as transformers, fans and circuit breakers) required as part of the North Island Grid Upgrade Project shall be designed and operated to ensure that the following noise limits shall not be exceeded:

- (a) **At** or within any land outside the designation:

All times	55dBA L_{10}
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- (b) **At** or within the boundary of any residentially zoned site:

All days 7am to 10pm	50dBA L_{10}
All nights 10pm to 7am	40dBA L_{10}
All nights 10pm to 7am	70dBA L_{max}

9. **SOUND** levels shall be assessed in accordance with NZS6802:1991 Assessment of Environmental Sound.
10. **A** design report shall be provided to the satisfaction of the Manukau City Council prior to the installation of the any new noise generating equipment that demonstrates compliance with these limits.

11. **WITHIN** one month of installation the new equipment shall be assessed at source for its sound power level using EN60076-10:2001-05 Power Transformers Part 10 Determination of Sound Levels.
12. **SOUND** levels shall then be predicted at the designation boundary. Monitoring and prediction shall be undertaken by a suitably qualified and experienced person within one month of the commissioning of any new equipment. The results of the noise monitoring shall be made available to the Manukau City Council upon request.
13. **TRANSPower** New Zealand Ltd shall review the noise levels and report to Manukau City Council at the time of each designation roll-over on progress that has been made to reduce noise levels progressively where it is necessary to replace transformers.

Brownhill Substation

14. **ALL** activities within the designation (except for construction and maintenance) shall be designed and operated to ensure that the following noise limits shall not be exceeded beyond the boundary of the designation:

All days	7am to 10pm	55dBA L ₁₀
All nights	10pm to 7am	45dBA L ₁₀
All nights	10pm to 7am	75dBA L _{max}

15. **EXCEPT** that any standby generators shall not exceed 55dBA L₁₀ at all times and shall only be operated for maintenance purposes between the hours of 7am to 10pm.

16. **ALL** activities within the designation (except for construction and maintenance) shall be designed and operated to ensure that the following noise limits shall not be exceeded within the notional boundary of any dwelling existing at the date of the Notice of Requirement:

All days	7am to 10pm	45dBA L ₁₀
All nights	10pm to 7am	35dBA L ₁₀
All nights	10pm to 7am	65dBA L _{max}

17. **SOUND** levels shall be measured and assessed in accordance with NZS6801:1991 Measurement of Sound and NZS6802:1991 Assessment of Environmental Sound.
18. **SOUND** monitoring shall be undertaken by a suitably qualified and experienced person within one month of the commissioning of any new transformer. The results of the noise monitoring shall be made available to the Manukau City Council upon request.

Overhead Transmission Line Designation

19. **The** operation of the transmission line shall not exceed a limit of L_{Aeq} 40dB under wet conductor conditions as defined in Chapter 6 of the EPRI Transmission Line Reference Book beyond the boundaries of the transmission line designation.
20. **SOUND** levels shall be measured and assessed in accordance with NZS6801:1991 Measurement of Sound and NZS6802:1991 Assessment of Environmental Sound.

Whakamaru and Whakamaru North Substation

21. **ANY** new equipment (such as transformers, fans and circuit breakers) required as part of the North Island Grid Upgrade Project shall be designed and operated to ensure that the following noise limits shall not be exceeded at or within any land outside the Designation:

All times	L_{Aeq} 40dB
All nights 10pm to 7am	75dBA L_{max}

22. **SOUND** levels shall be measured and assessed in accordance with NZS6801:1991 Measurement of Sound and NZS6802:1991 Assessment of Environmental Sound.