TRANSPOWER 400 kV PROJECT FACT SHEET
AUDIBLE NOISE

These background facts on Audible Noise have been prepared for Transpower by Marshall Day Acoustics Ltd.

If you have any further queries please call Transpower on 0800 33 88 66.

1 Background

Transpower's 400 kV National Grid upgrade project will consist of a new double circuit 400 kV transmission line between the Whakamaru and Otahuhu Substations. The transmission line will consist of towers, approximately 40 to 70 metres high, spaced at an average of about 400 metres, but varying based on the topography and other constraints. Transpower will be seeking to secure a minimum easement width of 65 m (but it could be more depending upon engineering requirements) across private and public land for the line route.

One of the environmental effects of the project will be audible noise from the transmission lines. In general terms, this noise will consist of wind-induced (aeolian) and electrically-induced (corona discharge) elements.

2 Wind-induced noise

Wind-induced noise includes broadband turbulent noise, and aeolian noise (tones or whistles that vary in frequency with the windspeed).

Turbulent noise is a characteristic of any structure, artificial or natural, and is not considered a nuisance. It is characteristic of trees and some landforms.

Aeolian noise ("wind-in-the-wires") is caused by vortex shedding (regular air fluctuations) across the conductor and are readily eliminated by modifying (or "spoiling") the airflow by a number of well-established engineering design methods. Aeolian noise is generally not a problem in practice.

Certain types of insulators, with a dished profile, can create a strong wind-induced tone at a single frequency (like blowing across the top of a bottle). This is different from aeolian noise in that the frequency of the tone is fixed, due to an aero-acoustic locking mechanism. This can be minimised by correct design of the insulator profile. The types of insulators for the 400 kV line will have a suitable profile to prevent this type of noise.

3 Corona discharge noise

Corona discharge noise consists of broadband noise (hiss, crackle, etc.) and is generally only audible under conditions of high humidity, such as during rain or fog.

Corona (and the associated discharge noise) is due to ionisation of the air surrounding the conductor, and occurs along the length of the conductor. The ionisation is caused by a voltage difference applied across a volume of air. It is the voltage difference and not the actual voltage itself that causes ionisation. For a round conductor, the voltage difference per unit volume of air reduces away from the conductor surface, creating a gradient, with the highest voltage difference being at the surface of the conductor. When this voltage gradient reaches a certain critical value, electrical discharges occur and produces corona. The larger the conductor diameter, the lower the surface voltage gradient, and hence the lower the ionisation effects including corona discharge noise.

Ionisation effects are largely determined by the conductor surface conditions. A rough conductor surface (with nicks, broken wire strands, bird droppings, etc.) will create a higher surface-voltage-gradient and hence more ionisation and noise. Under wet conditions, such as very light rain or fog, water drops form on the surface of the conductor and create localised high voltage gradients, causing increased ionisation and corona discharge noise.

Corona discharge noise is more prominent during heavy rain, but the duration of heavy rain periods is generally shorter than periods of light rain and in any case the corona noise tends to be obscured by the noise of the rain International best practice in assessing corona discharge noise effects considers light rain as being comparatively more prevalent and thus of greater nuisance potential.

The EPRI[1] *"Transmission Line Reference Book, 345kV and Above",* Chapter 6, provides empirically-derived formulae for predicting audible noise from overhead transmission lines. These formulae are considered to be reliable and represent International best practice.

Engineering solutions exist to ensure the conductor surface-voltage-gradient can be limited and thus ensure that noise is kept to a practical minimum. These solutions also have to consider other effects such as electric fields and radio frequency interference, to reach the best combination amongst a range of effects in line design, and ensure that all parameters meet the required standards.

4 Acceptable noise levels

New Zealand Standard NZS6802:1991, "*Assessment of Environmental Sound*" (referenced by most District Councils in their district plans), provides guidelines for the desirable upper limit of exposure to environmental noise for the reasonable protection of community health and amenity. The Appendix shows the sound levels that people are typically exposed to. A night-time

[1] **A publication by the Electric Power Research Institute, 1987**

upper level of 45dBA L_{10} [2] is recommended in NZS6802. The corresponding daytime level is 55dBA L_{10}. The night-time limit is generally considered to be the determining factor, as it is important to avoid sleep disturbance. Designing to meet the night-time level means that day-time levels will also be readily met.

A recent update to this Standard, NZS6802:1999 "*Assessment of Environmental Noise*", recommends a night time noise limit in the range of 35-45dBA L_{eq}[3]. Note that although L_{eq} has now been adopted as the noise descriptor, L_{10} continues to be used in most district plans. For a steady noise, L_{10} and L_{eq} can be considered equivalent.

The designation boundary for the transmission line will be chosen so that any audible noise levels are within acceptable limits at the boundary.

The noise level will be correspondingly lower at distances further away from the designation boundary, and within any dwellings near the boundary.

5 Substations

Transformer "hum" is the dominant noise source at substations. Transformer hum is caused by magnetostrictive forces within the core of the transformer. These magnetic forces cause the core laminations to expand and contract, creating vibration and sound at a frequency of 100Hz (twice the a.c. mains frequency), and at multiples of 100Hz (harmonics). Typically, the noise level does not vary with transformer load, as the core is magnetically saturated and cannot produce any more noise.

All new transformers are provided with a guaranteed sound power level that can be used to calculate the noise level at any location away from the substation. Experience has shown that this information is very reliable. Modern transformers are typically quieter than the equivalent older models.

The two substations associated with the 400kV line will be located close to existing substations at Whakamaru and Otahuhu.

Detailed design work still has to be undertaken for the substations, and a range of techniques will be used to ensure that transformer noise is avoided or mitigated so that required noise levels are achieved at nearby dwellings.

Further work is also required in designing the structure in South Auckland where the overhead lines terminate and the underground cables begin. Noise effects will be taken into account as part of that design.

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[2] **L_{10} is the noise level which is equalled or exceed for 10% of the time. L_{10} is an indicator of the mean maximum noise level and is used in New Zealand as the descriptor for intrusive noise (in dBA).**

[3] **L_{eq} is the energy average of the level of a varying sound over a specified period of time.**

6 Summary

The two types of noise effects from the 400 kV project will be the weather-dependent broadband noise from corona discharge along lines, and the steady “hum” from the transformers at the substations, at the ends of the line.

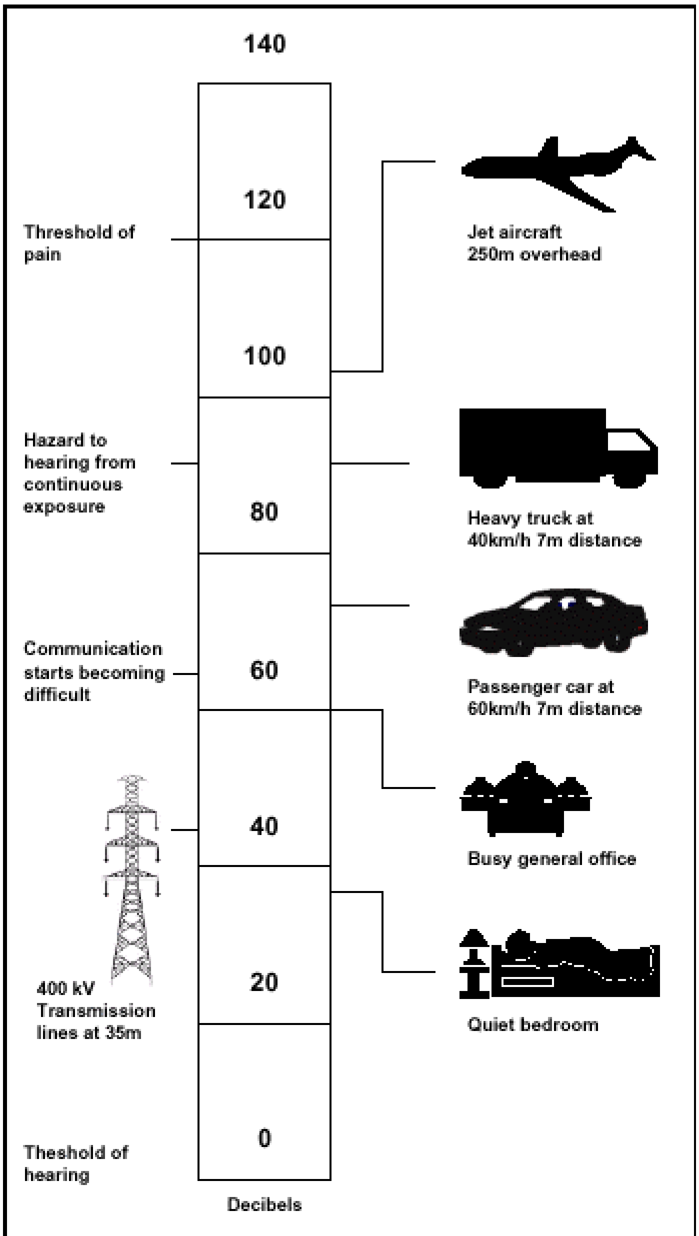
The design noise level target for substations will be that of the relevant district plans.

According to International best practice, the design noise level target for corona discharge noise should be that for “wet conductor” conditions. A design noise level target of 45dBA at the designation boundary along the length of the line will ensure that any adverse noise effects are no more than minor.

APPENDIX

The picture below diagrammatically represents typical noise levels in dBAs.

A dBA is a measurement of sound pressure level in decibels which has its frequency characteristics modified by a filter so as to more closely approximate the frequency bias of the human ear.



Transmission Line noise level comparisons