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

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STATEMENT OF EVIDENCE OF ROSS DOYLE COOPER IN REBUTTAL FOR TRANSPOWER NEW ZEALAND LIMITED (Magnetic Field Interference)

SIMPSON GRIERSON
D J S LAING / J G A WINCHESTER
TELEPHONE: +64-4-499 4599
FACSIMILE: +64-4-472 6986
DX SX11174: PO BOX 2402
SOLICITORS
WELLINGTON

J S KÓS QC
STOUT STREET CHAMBERS
TELEPHONE: +64-4-472 9026
FACSIMILE: +64-4-472 9027
PO BOX 117
WELLINGTON

Introduction

1. **MY** name is Ross Doyle Cooper. I wish to present rebuttal evidence to the statements of evidence of Mr Gary Orbell, on behalf of Matamata-Piako District Council (**Submission number 1113**).

2. **I** wish to address paragraph 5 of Mr Orbell's evidence in relation to "*precision agricultural systems*".

3. **MR** Orbell has expressed concern about the effect of transmission line EMF on GPS receivers, especially when those GPS receivers are used on "*precision agricultural systems*" that may come into use at some time in the future.

4. **AS** discussed in my first statement of evidence at paragraphs 60-70 and 103, a sample of a GPS receiver was tested at UL International Ltd. The GPS unit was found to operate without maloperation in a magnetic field having a strength of 50μT. This field strength is much higher than any field able to be produced by the 400 kV capable transmission line, either during maximum winter peak loading condition or any post contingency (fault) condition.

5. **WHILST** a GPS receiver can operate in 50μT mains frequency magnetic field, the signals that it receives from the network of GPS satellites can be blocked, attenuated, or distorted by such things as atmospheric disturbances, reflections from buildings, orbital errors, corona noise and metallic obstructions. Corona noise emits electrical noise (which I comment on in the 'Technical Glossary' section of my first statement of evidence). From about 1 MHz to about 1500MHz. GPS works on 6 discreet frequencies from 1100 MHz to about 1500MHz and there is the potential for corona noise to affect GPS operation by overriding the GPS signal with electrical noise.

6. **MR** Khot indicates in his evidence that the 400kV capable line has been designed so that corona initiation is unlikely to occur. This will result in the 400kV capable line having such low corona levels that they will not override any GPS satellite signals.

7. **METALLIC** obstructions can include the towers and conductors of a transmission line, in much the same way that those same towers and conductors can create

shadow areas for broadcast, cellular or microwave signals. I make reference to shadow effects at paragraphs 111-114 of my first statement of evidence, in response to concerns by Harry Kenneth Ruffell of Arapuni, regarding wireless internet services.

8. **THE** likely effect of a number of attenuated, distorted or blocked GPS satellite signals is that the GPS unit has to deal with 'bad signals'. All GPS receivers have algorithms that deal with bad signals, some better than others. Bad signals need to be identified and rejected and this leads to a delay in getting a good fix.

9. **IN** the GPS network, there are, at least, 24 satellites moving constantly along 6 orbital paths around the earth. GPS receivers need only 4 satellite signals in order to get a 3-dimensional fix of the receiver's location, through a process commonly called triangulation, or more correctly, trilateration. For a 2 dimensional fix, you need only 3 satellite signals. At any one time, though, there are anywhere between 6 and 12 satellites in view at any location on the earth. Accordingly, if there are a number of bad satellite signals, the GPS receiver can always get a good fix so long as there are at least 3 or 4 good signals. This fix will occur in time as satellites move into and out of view.

10. **THE** delay in getting a good fix is longest when the GPS receiver is in 'start up' mode or initialisation. Once the GPS receiver is initialised and a good fix is obtained, it is much easier to maintain a good fix and it can be used for navigation.

11. **THUS**, for maximum reliability, a GPS receiver needs to be initialised away from metallic obstructions, such as towers and transmission lines, which can attenuate, distort or block satellite GPS signals. Once a good fix has been obtained, it can be used to navigate 'precision agricultural equipment' under and around transmission lines.

12. **IT** should be noted that GPS receivers can have 'erroneous' fixes, even though the signals are good. This is often due to atmospheric disturbances which can cause minor delays in signal reception. These are times when a signal is not considered 'bad' enough to be rejected by the GPS receiver. Consequently, a GPS receiver can be sitting in one spot, taking fixes all the time, and its fix can vary as much as 2 m in every direction.

13. **IN** summary, there are a number of factors that affect GPS receivers that might be used on 'precision agricultural equipment'. The presence of the 400 kV capable transmission line on farms will, in my view, have a minor impact on the future use of GPS receivers for farming purposes. I note that, for a significant part of the overhead line route, there is already an existing transmission line (ARI-PAK A), which would have similar impacts on GPS operation. This line will be replaced by the 400 kV capable transmission line.

14. **THE** essential factor is how much the line and tower blocks the view of the sky. The proposed 400kV capable line has higher conductors but also has a larger structure so the end result will be similar to that of a standard 220kV line. All a transmission line can do is block or attenuate some of the satellite signals and there should be enough remaining satellites to provide at least 3 or 4 signals for the GPS receiver to have a good fix. This is the case for the 400 kV capable transmission line or any other transmission line.

Ross Doyle Cooper
11 April 2008