

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 DAVID EDWARD BOYLE IN REBUTTAL ON
BEHALF OF TRANSPOWER NEW ZEALAND LIMITED
(System planning)**

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Introduction

1. **MY** name is David Edward Boyle. I wish to present rebuttal evidence to the statements of evidence of:
 - (a) Mr Geoff Copstick and Ms Kate Brennan;
 - (b) Dr Paul Robinson;
 - (c) Mr John Makin;
 - (d) Mr Christopher Freke on behalf of Manukau City Council (**MCC**);
 - (e) Mr Lance and Mrs Donna Levesque; and
 - (f) Mr Doug Parker on behalf of Hunua and Paparimu Valley Residents' Association Incorporated.

2. I address the evidence of each of each submitter below.

Mr Geoff Copstick and Ms Kate Brennan (Submission number 0405)

3. **AT** the heading prior to paragraph 35 of their amended statement of evidence, Mr Copstick and Ms Brennan state that alternatives, all of which impose less environmental harm on New Zealand, have not been adequately investigated or costed by Transpower.

4. **MY** evidence in chief, as well as the evidence of Mr Tim George for Transpower, addresses the numerous alternatives considered. In my opinion, this evidence demonstrates that numerous alternative methods of resolving the security of supply problem to the upper North Island have been considered and assessed.

5. I note in particular at paragraph 134 of their amended statement of evidence, Mr Copstick and Ms Brennan state that the "*[t]he fiction that the alternative to this proposed line is two large 220kV lines is repeated throughout Transpower's evidence.*"

6. **TO** the extent that this relates to the assertion by Mr Copstick and Ms Brennan regarding the consideration of alternatives that "impose less environmental harm", I have addressed this issue at various places in my evidence in chief, including paragraphs 128 to 132, 186 to 198, 206, 208, 219, and 224 to 226. With respect to Mr Copstick and Ms Brennan, it is a fact that the primary 220kV alternative (a

high capacity double circuit 220kV line from Whakamaru to South Auckland, and 220kV cables from South Auckland to Pakuranga and Otahuhu) would require the construction of a second 220kV line in the future. The requirement for a second 220kV line is explicitly stated in the list of modelled projects in the Amended Proposal.

7. **IN** order for the 220kV alternative to provide comparable transmission capacity to the 400kV capable alternative, it would require the development of a second high capacity 220kV line, probably to replace the existing OTA-WKM A & B lines, in approximately 2034 (whereas at a similar time the 400kV capable line could simply be energised from 220kV to 400kV operation). Beyond 2042, the construction of further high capacity 220kV lines would be required on greenfields routes instead of a second 400kV line, nominally on the OTA-WKM A & B alignment.

Dr Paul Robinson (Submission number 0643)

8. **DR** Robinson raises concerns regarding risk management, natural disasters and system security in general.
9. **IN** particular, Dr Robinson has commented in paragraph 11 on the imprudence of having three transmission lines in a relatively narrow corridor, and has compared this to a particular failure of the towers on the HVDC line on 9 January 2004. There are two specific points that I will address in response:
 - (a) the event on the HVDC line he refers to is the failure of three consecutive towers on the HVDC transmission line, whereas the corridor that he refers to contains three separate transmission lines. The two situations are not in any way comparable, given that the three transmission lines are not physically connected to each other.
 - (b) the 400kV capable line has been designed as a high reliability transmission line and as such there are a number of mitigation measures included in the design and construction to ensure that it has a very low failure rate and has a very high availability. The reliability of the new 400kV line has been raised by a number of submitters previously and the reliability of the line has been addressed in paragraphs 161 to 185 of my evidence in chief. The fact that the proposed line is, in some locations, in

relatively close proximity to other lines, does not measurably affect its reliability nor measurably increase network security risks.

Mr John Makin (Submission number 0781)

10. **IN** response to Mr Makin's comments on quality of supply and reliability on page 8 of his evidence, as I have already noted, the proposed 400kV capable transmission line will be designed as a high reliability transmission line and will encompass good design and construction practices to ensure that it has a very low failure rate and that it has a very high availability.
11. **IN** that respect, there was considerable discussion and correspondence between Transpower and the Electricity Commission regarding the reliability of the proposed 400kV line, and issues similar to those raised by Mr Makin were raised by various submitters. Transpower has provided information on historical failures and the design and construction measures that will be included in the proposed line that will minimise the probability of similar events causing a double circuit outage of the proposed line.
12. **TRANSPOWER** has also reviewed the performance of 330kV and 500kV lines in Australia as a basis for comparison with higher voltage AC lines, given that none presently exist in this country. This is a brand new line, designed in accordance with the most up to date practices and standards. The performance of the structures is expected to meet or exceed the reliability achieved for 500kV lines in Australia. There have been no structure failures of 500kV lines in Australia, and there have only been a small number of double circuit 220kV tower failures in New Zealand. Transpower will be incorporating measures in the design and construction which will mitigate the structure failure modes that have been experienced previously in this country on other lines, and it is highly unlikely that there will be any structure failures on the proposed 400kV line over the life of the line.
13. **ON** page 10 of his evidence, Mr Makin comments on developments in technology, and infers that they might be useful substitutes for the 400kV capable option. A number of technological developments that Mr Makin refers to such as the High Temperature Conductors and HVDC technology, whether it be conventional HVDC or HVDC light, are already in commercial production and were assessed as part of the development of the North Island Grid Upgrade proposal. Both of these

options were found to be significantly more expensive than both the 220kV AC or 400kV AC options. I have commented on the use of high temperature conductor options in paragraphs 232 to 235 of my evidence in chief and on the use of HVDC in paragraphs 236 to 241 of my evidence in chief.

14. **WITH** regard to the potential use of superconductors for long distance transmission, it is difficult to predict what the future developments in the area will be. However, even if high capacity superconducting cables are developed for long distance transmission in the future, it is likely that they would be significantly more expensive than even conventional underground power cables. On a per kilometre basis, underground cables currently cost in the order of ten times more on average than the cost of the equivalent capacity overhead lines. Furthermore, superconducting cables may be technically feasible in the future but such technology is not commercially available now and would not be available in time to meet the forecast need date of 2013.

Mr Christopher Freke (MCC) (Submission number 0861)

15. **MR** Freke's assertion in paragraph 16 of his amended statement of evidence, that Transpower's policy has dictated from the outset that the project would comprise the greatest possible capacity line at the minimum cost possible, is factually incorrect. I will specifically address the comments on the Grid Investment Test and the capacity of the transmission line, as Mr Taylor discusses the process and consideration of environmental effects in his rebuttal evidence.
16. **THE** Grid Investment Test does drive a requirement for the least cost option and the original proposal was for a medium capacity 400kV transmission line, as it was considered by Transpower to be the lowest cost option. This view was not accepted by the Electricity Commission. However, clause 88E in the 2006 revision of the Government Policy Statement on Electricity Governance (**GPS**), specifically directed the Electricity Commission to take into account the longer term benefits that larger capacity lines may provide by avoiding multiple smaller lines. This change was the catalyst for the significant increase in the capacity of the proposed 400kV transmission line.
17. **WHILE** the explicit requirement introduced by the GPS to maximise the use of the transmission corridors did not exist at the early Grid Vision stages of the project or at the time that the Original Proposal was submitted to the Electricity Commission

in September 2005, as Mr Taylor explains in his rebuttal evidence, one of the key guiding principles for Transpower of the Grid Vision process was that "*the overall Grid Vision process be guided by the optimisation of transmission line corridors*". Therefore, I do not consider that Transpower has adopted an inconsistent transmission planning approach throughout the process in terms of environmental considerations – the key policy change was that introduced by the GPS which highlighted the importance of this consideration.

18. **MR** Freke's assertion in paragraph 19 of his amended statement of evidence, that the project has always been based on a 400kV transmission solution, and that this has never been negotiable, is speculative, in addition to being inaccurate and misleading. Mr Freke is correct that both proposals to the Electricity Commission have been for the construction a new 400kV capable line but the preference for and selection of the 400kV capable line has been a result of detailed assessment of a number of different options.
19. **IT** is correct that the Original Proposal (September 2005) was for a 400kV line, but this was preferred by Transpower after the investigation of a number of different technologies (including AC and HVDC) and different AC voltages; namely 220kV, 330kV, 400kV, and 500kV. The Amended Proposal considered four short-listed options, including both new 220kV and new 400kV lines. The results of the analysis confirmed that a 400kV solution was the most appropriate solution.
20. **MR** Freke asserts in paragraph 21 of his amended statement of evidence, that the only changes to the proposal have resulted from subsequent operational or cost considerations. The Original Proposal was based on termination at Otahuhu as it was the least cost solution, however it also included a proposal to split the Otahuhu bus, to improve diversity of the supply to the Auckland area. The Amended Proposal improves the supply diversity further by providing a physically separate transmission entry point to Auckland.
21. **AS** detailed in paragraph 186 of my evidence in chief and earlier in this rebuttal statement, one of the drivers is also the environmental consideration of seeking to reduce the number of additional transmission lines in the future, and Mr Freke is correct that Transpower has not changed its wider transmission planning approach between proposals. However, in the period between the two proposals, a relevant change in the GPS included the requirement to maximise the use of transmission corridors and recognise the longer term benefits that larger capacity

lines may provide by avoiding multiple smaller lines. These explicit policy directives enabled Transpower to incorporate express consideration of these important policy and transmission planning requirements in the assessment criteria.

- 22.** **MR** Freke asserts in paragraphs 22 to 27 of his amended statement of evidence, that Transpower's application of the Grid Investment Test was focused on internal costs only and ignored any cost imposed on the community. It is incorrect for Mr Freke to suggest that internal costs were the only considerations. My evidence in chief seeks to explain the complex process which occurs in transmission planning, and the numerous considerations (including costs, security and reliability, supply diversity, electrical engineering, policy considerations, environmental issues, and property issues) which need to be taken into account at different stages of the process.
- 23.** **ACCORDINGLY**, there are also a range of other important considerations which were relevant to Transpower's analysis of alternatives. These included considerations such as the Grid Reliability Standards (**GRS**) set under the Rules, the need to comply with good electricity industry practice, and also the direction within the GPS which enabled Transpower to consider the positive effects and long term environmental benefits of minimising the number of additional future transmission lines. Mr Freke has also overlooked the fact that, where environmental mitigation has been built into the project (often for the benefit of the community), such mitigation has a cost and these costs were expressly taken into account through the GIT.

Mr Lance and Mrs Donna Levesque (Submission number 0914)

- 24.** **IN** their amended statement of evidence, Mr and Mrs Levesque state that they agree with the submission from the Hunua and Papparimu Valley Residents' Association Inc on the technical issue of whether a line of this size is required. I address this issue below in response to Mr Doug Parker's evidence on this subject.
- 25.** **AT** the second to last page of their amended statement of evidence, Mr and Mrs Levesque have observed that most of the new renewable energy sources seem to be projected to come from the South Island, based on information contained in slides from an Electricity Commission renewables workshop (in Wellington on 17

December 2007). They assert that if this is the case then a HVDC Link should be considered.

26. **WITH** respect to the slides presented at the workshops, they did not in fact indicate that most new renewable energy would be sourced from the South Island. The presentations on wind generation only listed potential wind generation in the North Island as it was an ongoing investigation, while the presentation on hydro generation only discussed such generation in the South Island hydro system. The presentation on geothermal generation discussed the generation in the North Island, specifically in the Taupo/Bay of Plenty areas. The fact is that there is a significant potential renewable energy resource in the North Island. A number of other submitters have also commented on the location of future potential renewable generation and I have provided detailed comments in paragraphs 90 to 97 of my evidence in chief.
27. **THE** key point is that a significant proportion of any new renewable generation will inject into the 220kV network south of Whakamaru, requiring additional transmission capacity to deliver this energy to the major areas of demand in the upper North Island.
28. **WITH** regard to the practicability of building an extension of the HVDC link through to Auckland, this was raised by a number of submitters. I have provided detailed comments in paragraphs 240 to 245 of my evidence in chief. In summary, a HVDC option was not considered to be an appropriate solution due to high costs and risks, and lack of reliability and practicability.

**Mr Doug Parker (Hunua and Paparimu Valley Residents' Association Incorporated)
(Submission number 0748)**

29. **IN** paragraphs 11 and 12 of his amended statement of evidence, Mr Parker asserts that the capacity that the 400kV transmission line provides is far in excess of the future demand predictions.
30. **IN** paragraph 11, Mr Parker states that "*In Transpower's original 400kV Proposal (September 2005 GUP), power transfer requirements suitable for UNI load growth up to 2040 were claimed to be achieved with 2 X 1050 MVA circuits*". The inference that I draw from this paragraph in Mr Parker's evidence is that

Transpower has unjustifiably increased the capacity of the proposed line from what it had previously considered adequate.

31. TO the extent that Mr Parker's assertion has relevance to the present proposal, it appears that Mr Parker has misunderstood the 400kV development plans that were included as part of the 2005 Grid Upgrade plan. There were five 400kV development plans in the GUP, one for each generation scenario. The first three scenarios were developed by Transpower, as the first generation scenarios issued by the Electricity Commission were only issued in July 2005. However, the Transpower Grid Vision project, which sought to identify the need for increased security of supply into the upper North Island and various solutions to meet that need, had begun in 2003. Therefore both Transpower's and the Electricity Commission's later scenarios were considered.

32. EACH scenario used for assessing the Original Proposal had a different amount of generation in the Auckland area, and this generation influenced the need date for an eventual second 400kV line in the longer term (beyond the analysis period). The need dates for a possible second 400kV line are shown in the table below.

Scenario No	Scenario description	Need date for 2 nd 400kV line
1	Unconstrained gas (large amounts of gas fired generation in Auckland)	Later than 2040
2	Constrained gas, but coal or oil can be used instead with large amounts of coal fired generation in the upper North Island	Later than 2040
3	Carbon constrained – coal and gas fired generation will be limited	2020
4	Carbon constrained and HVDC (Southern Hydro)	Instead of 400kV line in 2020 there was a second HVDC line from the South Island to Auckland
5	Reduced demand – significant new generation in the upper North Island	Later than 2040

33. THE scenarios that included significant new generation in the upper North Island (1, 2, and 5) did not require a second 400kV line until later than 2040 because the increase in local demand would be supplied by local generation. It is these

scenarios that Mr Parker's comment appears to relate to. However, the scenarios that did not have significant local generation in the Auckland area (scenarios 3 and 4) required new transmission from the south in 2020. Scenario 3 (which has subsequently been considered to be the most realistic) required a second 400kV line in 2020. The 400kV transmission lines were both lower capacity double circuit lines with 2 x 1050 MVA circuits on each line, so once the second 400kV line was installed that would be a total of 4 x 1050 MVA circuits, not the 2 x 1050 MVA circuits as stated by Mr Parker.

- 34. UPDATED** development scenarios were used for considering the Amended Proposal. The development plan that was used in the Amended Proposal was based on the large hydro scenario that is described in the July 2005 SoO where there would not be significant new generation in the upper North Island, which is essentially Scenario 3 in the table above. As stated above, using a lower capacity 400kV option, a second line would have to be constructed in around 2020, but by using the high capacity 400kV line instead, a second 400kV line would not be required until after 2042.
- 35. PARAGRAPHS** 85 to 101 of my evidence in chief discuss the generation scenarios used for the Amended Proposal and the sensitivity testing which was undertaken on those scenarios. As a consequence of recent issues such as the adoption of the NZES, the Government's Renewables Bill, and the increased focus on renewable energy developments has subsequently borne out and reinforced the use of large hydro scenario for ascertaining the need date.
- 36. IN** paragraph 12 of his revised statement of evidence, Mr Parker states that the capacity of the new 400kV line will be larger than the total demand in 2037-2038. In my opinion, there are two things that Mr Parker appears to have misunderstood or overlooked. Firstly the 5400 MVA 400kV capable line is made up of two separate 2700 MVA circuits, one attached to each side of the tower (see paragraph 23 of my evidence in chief). Secondly, it is a mandatory requirement under the Electricity Governance Rules for the core transmission grid to be planned and operated to an "n-1" security standard where the grid will remain stable, and no demand should be interrupted, after the loss of the largest plant item (generation or transmission circuit) at times of peak loading. As the 400kV capable circuits (or alternative 220kV circuits) would be the largest single plant item in the upper North Island system, the n-1 security standard needs to be calculated with one circuit out of service.

37. **HENCE**, the 400kV capable line, operating at 400kV, would only add another 2700 MVA to the transmission capacity at "n-1", not the 5400 MVA that Mr Parker states. It should be noted that the 220kV alternative would only add 1450 MVA to the transmission capacity at "n-1".
38. **IN** paragraph 13 of his revised statement of evidence, Mr Parker asserts that the 400kV proposal poses a risk to supply security in the future. The risks to security of supply were also asserted by Mr Makin, and I have commented on these assertions earlier in my rebuttal statement.
39. **AT** paragraph 21 of his amended statement of evidence, Mr Parker makes a number of comments about tower heights and designs. The comments about the 220kV tower heights in the 10 November 2005 response to the Electricity Commission were based on a completely different line design and cannot reasonably be applied to the present proposal. The 220kV alternative in the Amended Proposal is a high capacity 220kV line with a similar number of towers and tower spacings to the 400kV capable line, and on the same alignment. This has resulted in higher structures, on average, for the 220kV alternative which was assessed by the Electricity Commission as part of its analysis of the Amended Proposal.
40. **SIMILARLY**, Mr Parker's comments on compact line design at paragraph 21 omit consideration of important factors. To ensure that the transmission system supplying the upper North Island has a high availability, the 400kV capable (and the 220kV alternative) transmission line needs to be designed for energised maintenance, so that the number of line outages for maintenance will be minimised.

- 41. THE** requirement for energised maintenance increases the distance between the bundles of the conductors vertically, and also the distance between the conductor bundle, which results in the structures being wider and higher. This is a fundamental safety requirement, and energised maintenance is integral to any new line of this nature. Maintenance requirements for the line will increase over time as the line ages, and it is my opinion that the use of compact designs would make energised maintenance difficult if not impossible.

David Edward Boyle

25 March 2008