



**T R A N S P O W E R**

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21 July 2006

Hon David Parker  
Minister of Energy  
Executive Wing  
Parliament Buildings  
WELLINGTON

Dear Minister

## **Transpower Response to Connell Wagner Recommendations**

Thank you for your letter of 7 July 2006 asking for Transpower's views on the recommendations flowing from the Connell Wagner report and on Transpower's plans for improving diversity of power supply into Auckland.

I also note your recent visit to the Otahuhu and Pakuranga substations, where you outlined the need for Transpower to articulate its vision for Auckland and provide this as a proposal separate to other grid upgrade plans. I'll touch on this as well in this letter, to provide an update on Transpower's progress with that project.

Transpower has responded positively to the Connell Wagner report, as it has also responded to the SKM and Pricewaterhousecooper's reports. Transpower is fully aware of the impact of the outage of 12 June and wishes to take prompt action in respect of processes and operations that can be improved to mitigate against the risk of potential outages.

To respond first to your questions on recommendations from the Connell Wagner report:

1. Electrically bond all the earthwire connections at Otahuhu and at similar substations elsewhere. They report bonding of some connections/joints but not others. I am aware that some of the earthwires have been or are being removed. For those that are staying, if you are not proposing to do this bonding, please explain why not.

*All remaining earthwires are now being bonded at Otahuhu substation. All other transmission line earthwire bonding at substations is now being inspected and this work will be completed by 31 July 2006. For some time now, Transpower's policy has been to electrically bond earthwires at all new installations and also when any major works were done at a site. Given the issues that have arisen, Transpower will now retrofit bonding at every location*

*where it is not presently bonded, and will do so in a priority order commencing with the supply into Auckland. This work will be complete by end of June 2007.*

*As you are aware Transpower's current policy for new installations is to bond line earth wires to substation structures and Transpower will check to ensure that this policy is properly applied.*

2. Underground the existing 220kV circuits that cross over the 110kV portion of the substation.

*Transpower is developing a proposal to install a physically separate, enclosed, high reliability 220kV substation on the Otahuhu site within two years of approval of the project. This proposal will include the undergrounding of the existing 220kV circuits that cross the 110kV substation. The two switchyards will be connected to permit switching and load sharing flexibility. The main incoming and outgoing 220kV circuits will be shared between the old and new switchyards.*

3. Remove all conductors and earthwires which cross over busbars at Otahuhu.

*The proposal outlined in 2 above will address this issue within two years. In the meantime the earthwires that fell on 12 June 2006 will not be replaced and the remaining earthwires and their connections have been rigorously inspected along with all other earthwires in Otahuhu substation.*

4. Introduce a higher level of risk analysis and maintenance management system (including physical audits) for sites or assets where the consequences of an outage are more significant, i.e. a form of tiered risk analysis and assessment.

*All third-party reports provided to the Minister have acknowledged that Transpower's current maintenance process is comprehensive; nonetheless Transpower recognises that there is an opportunity to develop an improved hierarchy in respect of the criticality of sites or assets. Transpower will initiate an additional regime of more frequent physical inspections where the consequences of an outage are considered to be more significant. This system will be in place by 30 November 2006 and fully implemented by June 2007.*

*As a separate issue, to ensure that other sites continue to receive adequate maintenance, Transpower may need to seek additional funding through the review of operating expenses that is being presently conducted by the Commerce Commission.*

### **Risk of failures**

Aside from maintenance issues raised in the Connell Wagner report, you have asked to understand where, in Transpower's view, the highest risk exists of single point failures and whether Transpower has a list of risk points, ordered by population or load, which would be cut off, including an assessment of the likelihood of such risks,

the magnitude of the impact and what mitigation measures have already been planned.

Transpower's view on the risk of single point failures is that the risk is greatest at substation facilities supplying major urban areas. There are two aspects of risks in power supply failures; one is the risk of losing the supply and one is the risk of plant or equipment failure (such as occurred at Otahuhu).

In terms of reliability of supply, network planning criteria ensure appropriate spare capacity is provided at these critical substation sites commensurate with the load being supplied. For example good electricity industry practice internationally is typically that loads above 10MW are supplied with N-1 security. This means, for example, that supply is not lost if one component is unavailable<sup>1</sup>.

As you will be aware, the outage at Otahuhu shows that the N-1 planning criterion needs to be strengthened in order to provide greater diversity and security of supply to Auckland. Transpower does not consider that N-1 is sufficient and Transpower's future investment plans address this issue, as described below.

In terms of the second aspect of risk to security of supply, that is, the risk of plant and equipment failure, as mentioned in the response to recommendation 4 above, Transpower will initiate a higher level of on-site inspections to ensure that risks to critical substation sites is minimised.

### **Transpower's vision for Auckland's supply future**

In your letter you asked to be updated on Transpower's plans for improving diversity of supply into Auckland.

I also note that during your recent visit to Otahuhu and Pakuranga substations, you discussed options for diversity with David Laurie and requested Transpower to produce a document that clearly sets out the vision and preferred strategy for this work, separately from the 400kV and particularly in regard to Auckland.

The development of supply options for Auckland has been underway for some time, though the most recent formal and public consultation phase commenced in May 2006 when Transpower initiated its *Request for Information* consultation process in the Auckland region. Submissions close on 5 August and Transpower expects to be able to fully outline its vision for Auckland by the end of November.

We are aware of the support in the Connell Wagner report for the eastern corridor but can not reach final conclusions about proposals under consideration until that RFI process is complete. Transpower's final document will take all issues raised into

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<sup>1</sup> Under the Electricity Commission's definition of Core Grid, only loads exceeding 150 MW are supplied at N-1, and then only for that load over 150 MW (e.g. a 200 MW load might have 50 MW at N-1 and 150 MW at only N security). For all other loads, N-1 would have to be justified under the Grid Investment Test. Transpower argued strongly but ultimately unsuccessfully for a more robust definition of the core grid.

consideration, to the extent permissible under the EGRs, taking into account, where possible, social, environmental and community issues.

Transpower will be proposing options consistent with good electricity industry practice for levels of diversity according to the importance of load, and its vision for New Zealand's supply future, explained below.

### **Transpower's vision for New Zealand's future grid**

In essence, our 220 kV transmission system has served the country well since it was built in the 1950s to 1970s but it is now reaching its capacity in several parts of the country. As has already happened in most like countries, it is sensible to make a step change in voltage for the next stage of investment. A higher voltage gives increased capacity (all else being equal, doubling the voltage quadruples the capacity), significantly lowers losses, and requires fewer corridors. After extensive analysis<sup>2</sup>, Transpower has reached the conclusion that the next voltage step for New Zealand should be to 400kV. In planning individual investments or groups of investments, a significant issue is therefore how to stage the transition to 400 kV.

Transpower's strategic plans deriving from and presented in its vision for New Zealand are for the 400kV line from Whakamaru to Otahuhu to provide additional capacity into Auckland as a first step in a national upgrade to 400kV as the backbone voltage, with other 400kV lines added when required including:

- Bunnythorpe to Whakamaru (extending the 400kV backbone south towards Haywards and Wellington);
- Stratford to Whakamaru (allowing improved market access to Taranaki generation);
- Whakamaru to Pakuranga (allowing additional capacity and diversity into Auckland).

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<sup>2</sup> Many submissions to the Electricity Commission's consultation on its draft "No" decision on Transpower's 400kV proposal pointed to the need for a vision for New Zealand's long term transmission future before informed decisions can be made on individual investments. In fact, Transpower has a solidly grounded and enduring vision for New Zealand's grid future, that has been:

- Developed as a major project within Transpower since 2001 (attached is a History of Transpower's Strategy prepared for the Commerce Commission as part of the Administrative Settlement Agreement)
- Published internally in extensive technical and economic reports, many of which were appended to Transpower's Grid Upgrade Plan of 2005;
- Summarised and publicised widely throughout New Zealand as Transpower's "Future of the National Grid" document in late 2003; and
- Formally submitted to the Electricity Commission in Transpower's Grid Upgrade Plan of 2005 (GUP) with the 400kV upgrade proposal.

Section III of Volume II of the GUP explained at length the vision out to 2040, with consideration of a wide range of voltages and technologies, concluding that 400kV was the most appropriate long term strategy for New Zealand. Grid maps were provided that showed how different 400kV (and some other) lines would be added over time out to 2040 depending on demand growth and generation investment.

Of special relevance to Auckland security is that Transpower's submitted long-term vision already includes a new 400kV line from Whakamaru to Pakuranga to provide additional capacity and diversity into Auckland. The context in which this should be considered is discussed below.

### Levels of diversity

Transpower is mindful of the lack of diversity that currently exists for supplies into Auckland. This situation has developed over time and is largely a consequence of the additional cost associated with the development of new substations and corridors to address low probability but high consequence events.

Diversity is achieved through the delivery of three fundamental characteristics:

- **Geographic diversity:** This is the physical separation of supply infrastructure to avoid local phenomena impacting on key assets or installations. Such phenomena could include major equipment failure (beyond that catered for in N-1 planning), localised weather events, civil unrest, localised problems such as gas leaks or more significant events such as earthquakes. Geographic diversity needs to be provided in three basic forms:
  - Switchyard
  - Locational diversity
  - Corridor diversity

These are tabulated in Figure 1 below.

		Cause of concern	Example of event resilient to	Example of transmission solution for South Auckland
Level of diversity	Switchyard	Single switchyard in a substation	Equipment failure Earthquake or extreme weather event	Second switchyard at Otahuhu Load switching capability
	Locational	All grid plant in a local area, say 2 by 2 km square	Civil unrest Earthquake or extreme weather event	Second substation eg. expanded Pakuranga Feed into Pakuranga from the South
	Corridor	Parallel lines within say 2 km of each other	Wilful damage Tower collapse Earthquake or extreme weather event	Through Auckland: Eastern line eg Southern Auckland to Penrose via Pakuranga To Auckland: Additional line on separate corridor to existing 220kV lines Whakamaru to Otahuhu <sup>3</sup>

Figure 1 – Required forms of geographic diversity for a load of Auckland's importance

<sup>3</sup> The three 220kV "A, B and C" lines that run on a common corridor.

- **Capacity:** Diversity is only achieved if the alternate facilities have the capability to supply a sizeable component of the load. Ideally, the diverse facilities should be capable of each supplying the entire load but this is seldom economically achievable.
- **Flexibility:** During emergency situations and routine maintenance plant outages, it is essential that the load can be re-arranged to be supplied off the alternate facilities. This effectively allows parts of the transmission grid to be temporarily bypassed.

Transpower has reviewed its plans and options for supplies to the Auckland area and considers that the appropriate processes to address supply reliability and diversity into the Auckland area can be broken down into three specific objectives that are discussed in the following sections.

### **Otahuhu substation**

Transpower considers that urgent action is required to improve the reliability and diversity of supplies at Otahuhu substation. As described in response to your questions on recommendations from the Connell Wagner report above, Transpower is proposing the following works:

- Electrically bond all the earth wire connections (question 1);
- Establish new physically and electrically separate switchyard with a high design level of reliability (question 2);
- The main incoming and outgoing 220kV circuits will be shared between the old and new switchyards;
- Interconnect the two switchyards with flexible switching arrangements (question 2);
- Underground the 220kV cross-overs (question 2); and
- Remove the cross-overs (question 3).

In terms of delivery of this project, Transpower believes the work can be completed within two years of project approval. A project plan is expected to be ready for approval in two to three weeks' time.

### **Augmentation of supplies to the Auckland region**

Transpower's 400 kV project (in both its original 400kV and envisaged staged 220/400kV configurations) includes the provision of a new switchyard at Otahuhu, described above, providing switchyard and corridor diversity into Auckland.

Transpower's vision, described above, would be in the long term (more than 20 years out) to build a second 400kV line from Whakamaru to Auckland, providing locational diversity in Auckland. This may involve the removal of a number of the old (existing) 220kV lines from the south but this is a matter for the future. The fact is that two double circuit 400 kV lines would be equivalent to six or more double circuit 220 kV lines, representing two rather than six new corridors into Auckland. If the second

(future) 400 kV line is built along an existing 220 kV corridor, the net effect is to create a reliable power supply future for a low environmental impact.

In the light of the 12 June 2006 event, it may be desirable to bring forward the achievement of locational diversity in Auckland. Transpower's 400kV project (original and revised) allows this to be achieved through adding – as a later project – additional cables from a location in the vicinity of the transition station near Ormiston Road<sup>4</sup> to Pakuranga and/or Penrose, in addition to those already proposed from there to Otahuhu.

The value of the option for greater diversity into and in Auckland that Transpower's 400kV proposal provides will be included in Transpower's amended proposal to the Electricity Commission for its approval. However approval of additional diversity projects, such as cables into Pakuranga, will be treated as separate projects to avoid delaying the priority objective of delivering supply reliability to Auckland.

Plans for reliability and diversity of supply for north Auckland will, as described above, be developed following responses to Transpower's *Request for Information*, and Transpower expects to be able to fully outline its vision for Auckland by the end of November, once the consultation and assessment of submissions is complete (see below).

### **Augmentation of supplies within Auckland**

Transpower commenced a formal consultation process in May to establish how best to address emerging transmission issues in the Auckland area. In essence, the consultation process is considering reinforcement of supplies from the south of Auckland all the way through to Albany in the north. The potential transmission solutions would include cables from Penrose to Albany via the central business district (Hobson Street) and the important Wairau Road substation.

Transpower is likely to recommend underground options for these projects as it is highly unlikely that corridors for overhead lines will be feasible or desirable.

Transpower is actively coordinating this work with Vector and will, for example, be seeking to finalise the negotiation of commercial terms for the joint use of the underground tunnel between Penrose and the central business district.

The processes associated with the intra-Auckland projects in the RFI will follow the requirements of the Part F rules and will result in the submission of a Grid Upgrade Plan to the Electricity Commission in about March 2007. The projects, if approved, should be delivered by 2012, subject to confirmation of the need through the consultation process.

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<sup>4</sup> The transition station is where the overhead lines go underground. It is planned to position the transition station close to Ormiston Road, south of Auckland.

I hope that what I have said in this letter addresses the questions you have put to us. If any further clarification is required, please let me know.

Yours sincerely

A handwritten signature in black ink that reads "David Gascoigne". The signature is written in a cursive style with a large, prominent 'D' at the beginning.

David Gascoigne  
Chairman



## Appendix 1 - Grid Development Plan Vision Foreword

As explained in the Transpower's Grid Upgrade Plan, 2005:

*The System Vision is intended to drive Transpower strategies and policies for the long-term growth and management of the Transmission System. It includes the two related initiatives of Grid Vision and System Operation Vision. A Grid Vision concept for the future transmission grid in 2020 and beyond was developed in phase 1 of the System Vision investigation. The executive endorsed the 2020 Grid Vision concept in July 2002 and requested a detailed investigation (phase 2) be undertaken to confirm the Grid Vision concept from technical, environmental and economic prospective.*

*The System Configuration work stream is one of the four major work streams in phase 2 of Grid Vision investigation. The objective of the System Configuration work stream is to carry out necessary system studies to establish transmission grid augmentations required to meet system demand up to 2040. A further objective is to assist with necessary studies for the other main areas of the investigation project.*

*The System Configuration work stream is responsible for the following tasks in a logical order:*

- a) Identify issues on this existing transmission grid,*
- b) Identify possible development options which can resolve all issues and provide sufficient transmission capacity for the next 40 years and beyond,*
- c) Produce draft development plans for each of the development options, and contribute to decision making on the preferred development option,*
- d) Carry out necessary system studies to refine the draft development plan from task c), and provide support to the other work streams of the investigation project.*

*Tasks a) and b) was completed in July 2003 and three broad options (or high level options) was identified as the possible directions for the future (long term) National Transmission Grid. They are:*

- 1. The 220 kV option, in which the highest voltage in the national grid will remain at 220 kV for the next 40 years,*
- 2. The 330 kV option, in which some of the existing transmission lines will be converted/rebuilt to 330 kV to supply the demand growth in the next 40 years and beyond,*
- 3. The 400 kV option, in which some 400 kV lines will be built within or in parallel with the corridors of the existing 220 kV lines. These 400 kV lines will (after commissioned) eventually replace the 220 kV lines in parallel with them.*

*Task c), the high level studies were carried out between July and October, 03. In this high level study phase, the North Island power system was broken down into several transfers. System developments for each transfer were determined based on analysis of transfer requirements and load ability of transmission lines at the three voltage levels. Load flow studies are also carried out to test the developments for 2010 and 2040, to calculate losses and to estimate additional reactive power requirements. The last task, task d), the refinement studies, was carried out between Oct, 03 and Jan. 04.*