MAY 2009

Grid Upgrade Plan 2008 Instalment 3

Part IX: Marsden Substation Investment Proposal

Keeping the energy flowing

TRANSPOWER

Transpower New Zealand Limited The National Grid

Executive Summary

Transpower's Marsden Substation Investment Proposal

The purpose of this Marsden Substation Investment Proposal (the **Proposal**) is to obtain Electricity Commission (the **Commission**) approval to recover the full costs (up to $6.4 million) associated with upgrading the 220 kV bus and 110 kV bus to ring bus configuration with bus couplers and duplicate two-zone protection.

Proposal at a Glance	
What:	Rearranging the 220 kV and 110 kV buses at Marsden to accommodate bus couplers and zone protection
When:	Commissioning in 2010
How much:	Transpower is seeking approval to recover up to $6.5 million

Background to the Proposal

The Marsden 220 kV and 110 kV buses are part of the core grid as defined in Schedule F3A of Section III of Part F of the Electricity Governance Rules (the **Rules**).

There are no bus couplers installed on the Marsden 220 kV and 110 kV buses and there is no protection scheme on the 110 kV bus. A fault on either of the 220 kV or 110 kV buses would result in the loss of the Marsden 220/110 kV interconnection and leave the Dargaville, Kaitaia, Kaikohe, Kensington and Maungatapere loads to be supplied through the 110 kV circuits from Henderson to Maungatapere. The capacity of these circuits (56 MW/68 MW – summer/winter ratings) is not sufficient to meet peak demand of these loads and load shedding would be required. Therefore the Grid Reliability Standard (the **GRS**) is not met for those assets. This Proposal will ensure that the Marsden substation meets the GRS.

The Proposal is to install duplicate bus zone protection and bus couplers on the Marsden 220 kV and 110 kV buses so that a fault on either bus will result in the loss of a bus section only and the Marsden 220/110 kV interconnection will not be lost.

Options considered

The Northland 110 kV network comprises a double-circuit line from Henderson to Maungatapere with further 110 kV double-circuit lines continuing to Kaikohe, Marsden and Kensington. Beyond Kaikohe there is a single-circuit 110 kV line to Kaitaia. The line to Maungatapere has off-take points at Wellsford and Maungaturoto.

Five alternatives to the Proposal were considered with the most comparable being to thermally uprate the Henderson–Maungatapere line. Given this is a reliability investment proposal on the core grid, the choice between the options is to be determined by reference to maximising expected net market benefits or minimising expected net market costs.

Option costs

The costs have been estimated at a level of accuracy commensurate with the estimated capital expenditure for these investment options. Costs are estimated at $10.7 million for the Reference Case (the thermal up-rating option) and $5.7 million for the Proposal.[1]

[1] These costs exclude provision for price contingency, interest during construction and inflation.

Application of the Grid Investment Test (GIT)

Transpower considers that there is no material difference between the options when assessed by reference to expected market benefits. Therefore, in testing the two options against the GIT, the assessment becomes a cost comparison, with the lower cost option satisfying the GIT.

The GIT results are shown in Table 0-1:

Table 0-1: Grid Investment Test Results

Present Value $NZ million	Transmission costs
Proposal - MDN	5.7
Reference Case – HEN/MPE	10.7

The Proposal – installing bus couplers and duplicate bus zone protection at Marsden – is the least-cost option and therefore passes the GIT.

Accuracy of GIT

Transpower recognises there is inherent uncertainty in the cost assumptions used in the GIT analysis. However, Transpower considers the rigour and comprehensiveness of the analysis undertaken is commensurate with the estimated capital expenditure required for the proposed investment.

Timing

As the configuration of the Marsden substation does not currently meet the GRS, the timing for the Proposal is to implement the upgrade as soon as possible. It is expected that the Proposal could be installed and commissioned in 2009/10.

Maximum Approval Cost

For the purposes of the GIT, the costs used are an Expected Cost, being the Estimated Cost plus a scope allowance, in current year dollars - $2009 in this case.

For approval purposes, a Maximum Approval Cost (**MAC**) is calculated, being a reasonable maximum expected cost for the project, in commissioning year dollars. The MAC is similar, but not the same, as previous proposals which included the use of a P90 figure (being the figure for which there is a 90% probability of the actual costs falling within the figures quoted).

The MAC, being the amount for which approval is sought from the Commission, is shown below in comparison to the Expected Cost and an Expected End Cost, which is the cost Transpower expects the Proposal to cost in commissioning year dollars. The Expected End Cost is similar to the old P50 figure.

Table 0-2: Approval Cost

$NZ million	Estimated Cost	Expected Cost	Price contingency	Exchange rate variability	Inflation	IDC	TOTAL
Expected Cost	5.2	5.7					5.7
Expected End Cost	5.2	5.7	0.3	-	0.2	0.1	6.3
Maximum Approved Cost	5.2	5.7	0.4	0.1	0.2	0.1	6.5

This Document

The remainder of this document is Transpower's formal submission to the Commission for approval of the costs of the Proposal. It is split into two parts:

- Part A sets out the actual proposal for which approval of cost recovery up to $6.5 million is sought; and
- Part B sets out the technical and economic analysis of the proposal and justifies the Proposal against the requirements of the Rules.

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Part A – Proposal

This part describes Transpower's Marsden Substation Investment Proposal (the **Proposal**).

Transpower is seeking Commission approval to recover the full costs associated with implementing the following programme of works:

Components of the Proposal

- Upgrade the 220 kV bus to a ring bus configuration to accommodate a single bus coupler and duplicate two-zone protection.
- Upgrade the 110 kV bus to a ring bus configuration to accommodate a single bus coupler and duplicate two-zone protection.

Timing

As the configuration of the Marsden substation does not currently meet the GRS, the timing for the Proposal is to implement the upgrade as soon as possible. It is expected that the Proposal could be installed and commissioned in 2009/10.

Costs

On commissioning of the Proposal, Transpower seeks approval to recover the full costs associated with implementing the Proposal up to a total amount of $6.5 million. This amount is the estimated MAC to implement the Proposal, based on the timing above, expressed in New Zealand dollars exclusive of GST.

Appendix C describes how the MAC has been derived.

Part B – Justification

1 Introduction

1.1 Purpose of the Proposal

The purpose of the Proposal is to obtain Commission approval to recover the costs associated with implementing a solution to ensure reliable electricity supply for the Northland area should there be a fault on the Marsden 220 kV or 110 kV buses.

The purpose of this Part of the document, Part B, is to provide information for:

- persons who are likely to be substantially affected by the Proposal; and
- the Commission to assess compliance of the Proposal with the Rules.

1.2 Document structure

Part A of this document contains the investment proposal.

Part B describes the processes followed and information analysed by Transpower in reaching its decision to seek approval from the Commission to recover the costs associated with implementing the Proposal set out in Part A. Part B is not therefore part of the Proposal as such, but contains the justification for it.

Part B is designed to lead readers through the process Transpower has followed in applying the GIT and to present the conclusions of the GIT analysis.

The attachments provide the detail of the analysis presented in this document.

1.3 The Proposal as part of the 2008 Grid Upgrade Plan (GUP)

This document forms Part IX of the 2008 GUP.

Transpower has already submitted the following parts of the 2008 GUP to the Commission:

- Part I: Comprehensive Plan for Asset Management and Operation of the Grid;
- Part II: Investment Contracts;
- Part III: Wairakei Ring Investment Proposal;
- Part IV: Maungatapere Bus Security Investment Proposal;
- Part VI: Woodville–Mangamaire–Masterton Transmission Investment Proposal;
- Part VII: Bombay Bus Security Investment Proposal; and
- Part VIII: Redclyffe Bus Security Investment Proposal.

1.4 Compliance with the GUIRP

Transpower notes that the development of the investment proposal and alternative option, and the analysis of those options, does not follow in a number of respects the processes and policies set out in the Grid Upgrade and Investment and Review Policy (GUIRP).

However, for smaller projects, Transpower has abbreviated the process consistent with the principles that the analysis undertaken in applying the Grid Investment Test (GIT) be

commensurate with the estimated capital expenditure required for the proposed investment.[2] This approach reflects one of the key principles of the GUIRP.[3]

1.5 Glossary/terminology

A glossary of terms and acronyms used in the Consultation Paper is included in Appendix A.

All references to Rules in this document refer to those in Section III of Part F of the Electricity Governance Rules 2003 unless otherwise specified.

2 Transmission Need and Type of Investment

2.1 Background to the Proposal

The Marsden 220 kV and 110 kV buses are part of the core grid as the 220 kV Huapai–Marsden, 220 kV Bream Bay–Marsden, and 110 kV Marsden–Maungatapere transmission links are listed in the Core Grid Determination, set out in Schedule F3A of the Rules.

There are no bus couplers installed on the Marsden 220 kV and 110 kV buses and there is no zone protection scheme on the 110 kV bus. A fault on either of the 220 kV or 110 kV buses would result in the loss of the Marsden 220/110 kV interconnection and leave the Dargaville, Kaitaia, Kaikohe, Kensington and Maungatapere loads to be supplied through the 110 kV circuits from Henderson to Maungatapere. The capacity of the Henderson to Maungatapere circuits (56 MVA/68 MVA – summer/winter ratings) is not sufficient to meet peak demand of these loads (see the map of the affected area in Figure 2-1 below) and load shedding would be required.

Therefore the Marsden 220 kV and 110 kV buses do not currently meet the “n-1” security standard on the core grid required by clause 4.2 of the GRS.

The Proposal is to install duplicate bus zone protection and bus couplers on the Marsden 220 kV and 110 kV buses so that a fault on either bus will result in the loss of a bus section only and the Marsden 220/110 kV interconnection will not be lost. This Proposal will ensure that the Marsden substation meets the GRS.

[2] Clause 12, Schedule F4 of the Rules.

[3] Grid Upgrade Investment and Review Policy, June 2008, para 2.1.1(h).

Figure 2-1: Northland Region

2.2 Investment Programme

This Proposal covers the work set out below:

- upgrade the 220 kV bus to a ring bus configuration to accommodate a single bus coupler and duplicate two-zone protection; and
- upgrade the 110 kV bus to a ring bus configuration to accommodate a single bus coupler and duplicate two-zone protection.

2.3 Type of investment

Transpower considers that the Proposal is a “reliability investment” under the Rules as:

- the Proposal is an investment by Transpower in the grid;
- the primary effect of the Proposal is to reduce expected unserved energy on the grid; and
- the expected unserved energy will result from likely planned or unplanned outages of primary transmission equipment.

2.4 Project Costs

The project costs given below exclude contingencies and interest during construction.

Marsden Substation Upgrade Costs	$000's
Primary Equipment	2,187
Secondary Equipment and Protection	2,347
Site Works	46
Project Management and Design	1,113
Total	5,692

3 Identification and Consideration of Options

3.1 Requirements under the Rules

The application of the GIT requires an analysis and comparison of the expected net market benefits and costs of a proposed investment and those of a number of alternative projects. Therefore Transpower must first identify those options that fall within the definition of "alternative projects" under the Rules.

3.2 Short-list options

Under the Rules, the GIT requires that a reliability investment proposed by Transpower, that is necessary to meet the reliability standard set out in clause 4.2 of the GRS, must maximise the expected net market benefits or minimise the expected net market costs compared with a number of alternative projects.[4]

Accordingly, Transpower must identify a number of options in addition to the Proposal that fall within the definition of "alternative projects" under the Rules. To identify options for consideration, Transpower has undertaken a process which included the following stages:

- confirming the need for the investment;
- identifying all options to address the identified need;
- assessing all the options to identify a short-list of options that in the circumstances can reasonably be considered as alternative projects; and
- confirming the short-list of options.

This process resulted in the selection of the Proposal and the alternative project described below.

3.3 Alternative projects

Under the Rules,[5] "alternative projects" are defined as:

> *""**Alternative projects**" means any alternative transmission augmentation projects and **transmission alternatives** to the **proposed investment**, including any variant of the **proposed investment** that involves a non-negligible change in the timing of that **proposed investment**, that are:*
>
> *19.1. technically feasible;*

[4] Clause 4.1, Schedule F4

[5] Clause 19, Schedule F4.

19.2. reasonably practicable having regard to the matters set out in clauses 8.1 to 8.4;

*19.3. reasonably likely to proceed if neither the **proposed investment** nor any other **alternative project** proceeds and unlikely to proceed if the **proposed investment** does proceed;*

*19.4. reasonably expected to provide similar benefits, in type but not necessarily in magnitude, to relevant nodes, as the **proposed investment**; and*

*19.5. reasonably expected to enable the deferment of investment of the type contemplated by the **proposed investment** for a period of 12 months or more."*

In addition,[6] the alternative projects to be considered in the GIT must be limited to:

> "…*those appropriate in number and technology given the cost magnitude of the **proposed investment**, the complexity of the required modelling and the urgency of the **proposed investment***."

In developing a short-list of options, Transpower considered a number of potential alternative projects:

i. Permanently split the Marsden 220 kV and 110 kV buses by opening bus disconnectors. This arrangement would comply with the GRS as faults on the Marsden 220 kV and 110 kV bus sections would not result in a loss of Marsden 220 kV interconnection. However, it would result in the GRS not being met at Bream Bay for the loss of the Huapai–Henderson circuit.

ii. Thermally up-rate the Henderson–Maungatapere line from 56/68 MVA to 96/105 MVA (summer/winter) so that the Northland 110 kV network load can be supplied without shedding load as a result of the loss of the Marsden 220/110 kV interconnection. The cost of this alternative would be around $10.7 million.

iii. Build a new 220 kV/110 kV interconnection in the area to duplicate the Marsden 220/110 kV interconnection so that the Northland 110 kV network load can be supplied without shedding load as a result of the loss of the Marsden 220/110 kV interconnection. If this were to be at Bream Bay, the cost would be around $37 million.

iv. Build a new 110 kV line between Henderson and Maungatapere so that the Northland 110 kV network load can be supplied without load shedding as a result of the loss of the Marsden 220/110 kV interconnection. A lead time of 5-7 years rules out this option when investment is needed now to meet the GRS.[7] Transpower considers that the easement costs required alone for the 136 km stretch between Henderson and Maungatapere would most likely exceed the Expected Cost of the Proposal.

v. Rearrange the Marsden 220 kV and 110 kV bus configurations in a manner other than by installing single bus couplers (e.g. move to a breaker and a half configuration). This option would cost considerably more than the Proposal as more circuit breakers would be required and considerable costs incurred in shifting existing plant and structures to implement the new bus configuration.

We have not considered Option i further since splitting the buses at Marsden would result in the GRS not being met at Bream Bay in the event of losing the Huapai–Henderson circuit. Options iii, iv and v are considerably more expensive than the proposal and are excluded on this basis.

[6] Clause 11, *ibid*.

[7] The option would not comply with clause 19.5 of the GIT.

Option ii is much closer in cost to the proposal so Transpower considers it reasonable to consider this option the only alternative project.

3.4 Reflecting Good Electricity Industry Practice (GEIP) in meeting the GRS

In order for the Commission to approve a reliability investment, the proposed investment must reflect GEIP in meeting the GRS.

3.4.1 The short-list options reflect GEIP

The Rules define GEIP in relation to transmission as:

> *"The exercise of that degree of skill, diligence, prudence, foresight and economic management, as determined by reference to good international practice, which would reasonably be expected from a skilled and experienced* ***asset*** *owner engaged in the management of a transmission network under conditions comparable to those applicable to the* ***grid*** *consistent with applicable law, safety and environmental protection. The determination is to take into account factors such as the relative size, duty, age and technological status of the relevant transmission network and the applicable law."*

Accordingly, comparable international practice should be considered in assessing what is GEIP in terms of grid investment planning. Transpower, as a prudent planner, owner and operator of a transmission network, must adopt solutions consistent with good international practice.

Transpower considers that all the short-list options reflect GEIP. Specifically, the approach taken for the Proposal is consistent with international practice as being a prudent investment given the size, nature and importance of the Northland area load.

3.4.2 The short-list options meet the Grid Reliability Standards

The GRS are contained in Schedule F3 of the Rules. These provide that the grid satisfies the grid reliability standards if:

> *"4.1 the power system is reasonably expected to achieve a level of reliability at or above the level that would be achieved if all* ***economic reliability investments*** *were to be implemented; and*
>
> *4.2 with all* ***assets*** *that are reasonably expected to be in service, the power system would remain in a* ***satisfactory state*** *during and following any* ***single credible contingency event*** *occurring on the* ***core grid****."*

As the Marsden substation concerns the core grid, any reliability investment must meet both clauses 4.1 and 4.2 of the GRS. Transpower considers that both short-list options meet the GRS as required by Rule 13.4.1.1.

3.5 Base case

For the purposes of the GIT, the Rules also require that the Proposal and the alternative projects be assessed against a base case, which is defined[8] as follows:

[8] Clause 20 of Part F Section III Schedule F4.

> ***"Base case"*** *means the* ***market development scenarios*** *developed for the reasonable future state of the electricity industry without the* ***proposed investment*** *or any* ***alternative project****.*

As noted by both the Commission and Transpower in analysis of the North Island Grid Upgrade Proposal, and more recently in the Maungatapere Bus Security Investment Proposal, it is difficult to identify a suitable base case for the analysis when an investment proposal is required to meet the GRS, and more particularly Rule 4.2 of the GRS because the base case must meet the GRS, but not be an alternative project.

The Commission has previously resolved this issue by using one of the "alternative projects" as a reference case. Transpower has adopted this approach.

4 Application of the Grid Investment Test

4.1 Compliance with the Grid Investment Test

As the Proposal concerns the core grid and must therefore meet the grid reliability standard set out in clause 4.2 of Schedule F3, the Proposal will satisfy the GIT under clause 4.1 of Schedule F4 if:

- the **proposed investment** maximises the **expected net market benefit** or minimises the **expected net market cost** compared with a number of **alternative projects**; and
- if sensitivity analysis is conducted, the conclusion (on net market benefits or net market costs) that a **proposed investment** satisfies clause 4.1.1 is sufficiently robust having regard to the results of that sensitivity analysis.

4.2 Analytical approach and market development scenarios

The economic analysis presented in this report differs in form, but less so in substance, from that used for analysis of major transmission investment proposals such as the HVDC Grid Upgrade Investment Proposal. The difference in substance arises because the Marsden Substation project's scale is much smaller, both in terms of cost and complexity. The Rules require that:

> *"The rigour and comprehensiveness of the analysis undertaken in applying this* ***grid investment test*** *must be commensurate with the estimated capital expenditure required for the* ***proposed investment****."* [9]

Transpower's economic analysis for the Proposal focuses on the capital cost effects of the short-list options, as these areas are the principal sources of market benefits and costs. Transpower considers that this approach is commensurate with the Rules given the estimated capital expenditure for the Proposal.

4.3 Application of the GIT

Table 4-1 presents the summarised rankings of the short-list options from applying the GIT.

[9] Clause 12, Schedule F4.

Table 4-1: GIT Results, ranking of the Proposal and Reference Case

Item	Reference Case: Uprated Henderson-Maungatapere line	The Proposal: Bus Upgrade Work Programme
	Mean Present Value 2009$M	
Net Market Cost	10.7	5.7

The results show that the Proposal – the Bus Upgrade option – has the lower expected net market cost of the two options. It therefore satisfies the GIT.

4.4 Timing of the Proposal

As the configuration of the Marsden substation does not currently meet the GRS, the timing for the Proposal is to implement the upgrade as soon as possible. It is expected that the Proposal could be installed and commissioned in 2009/10.

5 Compliance with the Processes set out in the Rules

The Commission may approve a proposed reliability investment where the proposed investment complies with the processes set out in the Rules. Transpower notes that the Commission interprets this rule as requiring that Transpower must comply with the processes required *by* the Rules in relation to the proposed investment under consideration.

The processes in the Rules require Transpower to:

- submit a grid upgrade plan in accordance with Rule 12.2;
- comply with any requests from the Commission prescribed in writing to provide information it considers is reasonably required to enable it and interested persons to evaluate the proposed investment – Rule 12.3.4;
- comply with the timetable for consultation and approval of reliability investments proposed in Transpower's grid upgrade plan, agreed between Transpower and the Commission, or as stipulated by the Electricity Commission, in accordance with Rule 13.2; and
- respond to any requests for further investigation or further information in accordance with Rule 13.3.3.

The processes under the Rules that Transpower follows in respect of potential investments are project-specific and accordingly do not assist in differentiating between the short-list options.

5.1 Submission of a Grid Upgrade Plan

Rule 12.2.1 provides that either:

- Transpower must submit a grid upgrade plan to the Commission within 3 months of receiving a written request from the Commission, or such other date as the Commission agrees; or
- Transpower may submit a grid upgrade plan for the Commission's consideration at any other time.

Transpower has not received a written request for submission of a grid upgrade plan (GUP). Transpower is submitting this document, as part of its 2008 GUP to the Commission.

5.2 Provision of information

Rule 12.3.4 requires a grid upgrade plan to, amongst other things, include:

> "*such other content as prescribed in writing by the **Board**, to ensure that **grid upgrade plans** includes such information that the **Board** considers is reasonably required to enable the **Board** and interested parties to evaluate **proposed transmission investments**, such as indicative pricing impacts of **investment proposals***."

The Commission has not requested any information under Rule 12.3.4. No further requests for information under Rule 12.3.4 or otherwise were made.

Accordingly, Transpower has complied with the requirements of Rule 12.3.4.

5.3 Compliance with the timetable and process

Rule 13.2.1 requires the Commission and Transpower to agree a timetable for consultation and approval of reliability investments. In the absence of agreement, the Commission may stipulate such a timetable.

Additionally, the Commission must consult with Transpower on the process for consultation and persons who the Commission will consult with.

Transpower and the Commission have agreed on a timetable for consultation and approval of the Proposal, including persons who the Commission will consult with.

Transpower considers that, to date, it has complied with the timetable and process agreed with the Commission.

5.4 Requests for further investigation and further information

Under rule 13.3.3, the Board may:

- direct Transpower to undertake further investigations into its proposed reliability investment;
- ask questions of Transpower or require further information or consultation on part or all of Transpower's Proposal;
- ask Transpower to evaluate alternative reliability investments; and
- where Transpower possesses relevant expertise, ask Transpower to evaluate transmission alternatives.

The Commission has not requested any information under rule 13.3.3. Transpower will endeavour to continue to comply with any reasonable requests the Commission may have in accordance with the above requirements.

6 The Proposal meets the Rule Requirements

As the Proposal is a "reliability investment", the Commission can approve the Proposal under rule 13.4.1, if the Proposal:

- reflects good electricity industry practice (GEIP) in meeting the Grid Reliability Standards (GRS);
- complies with the processes set out in the Rules; and
- meets the requirements of the GIT.

Transpower considers the Commission may approve the Proposal on the grounds that it satisfies the criteria under rule 13.4.1.

7 Approval Amount for the Proposal

7.1 Approval amount sought

This application seeks Commission approval to recover the lesser of actual costs or the estimated Maximum Approved Cost (MAC) of the Proposal. The Expected Cost of the Proposal, as used in the GIT, is estimated to be $5.7 million and the MAC of the Proposal is estimated to be $6.5 million.

7.2 Approval amount methodology

Previously, Transpower has used what is known as a P90 methodology to calculate the approval amount. For this Proposal, Transpower has used a simplified methodology to determine a formulaic MAC. This allows for variations in such items as financing costs, exchange rates and commodity prices, i.e. costs typically beyond the control of Transpower. Transpower considers the use of a MAC aids transparency and makes tracking of project costs against the approved amount much simpler.

It is worth noting that the cost of foreign exchange hedging is included in the MAC.

The amount for which approval is sought from the Commission is shown below, in comparison to the Expected Cost, as used in the GIT analysis, and the Expected End Cost, which is the cost Transpower expects the Proposal to cost. The Expected End Cost is similar to the old P50 figure.

Table 7-1: Expected Cost and Maximum Approved Cost Comparison

$NZ million	Estimated Cost	Expected Cost	Price contingency	Exchange rate variability	Inflation	IDC	TOTAL
Expected Cost	5.2	5.7					5.7
Expected End Cost	5.2	5.7	0.3	-	0.2	0.1	6.3
Maximum Approved Cost	5.2	5.7	0.4	0.1	0.2	0.1	6.5

Appendix C describes how the MAC has been derived. It is based on a cost estimate derived in May 2009.

For comparison, Transpower has calculated a P90 figure for the Proposal, using the same approach as used in previous GUPs. The MAC and P90 are shown in Table 7-2 below:

Table 7-2: Maximum Approval and P90 Costs, $ million

MAC	P90
6.5	6.5

Appendix A Glossary

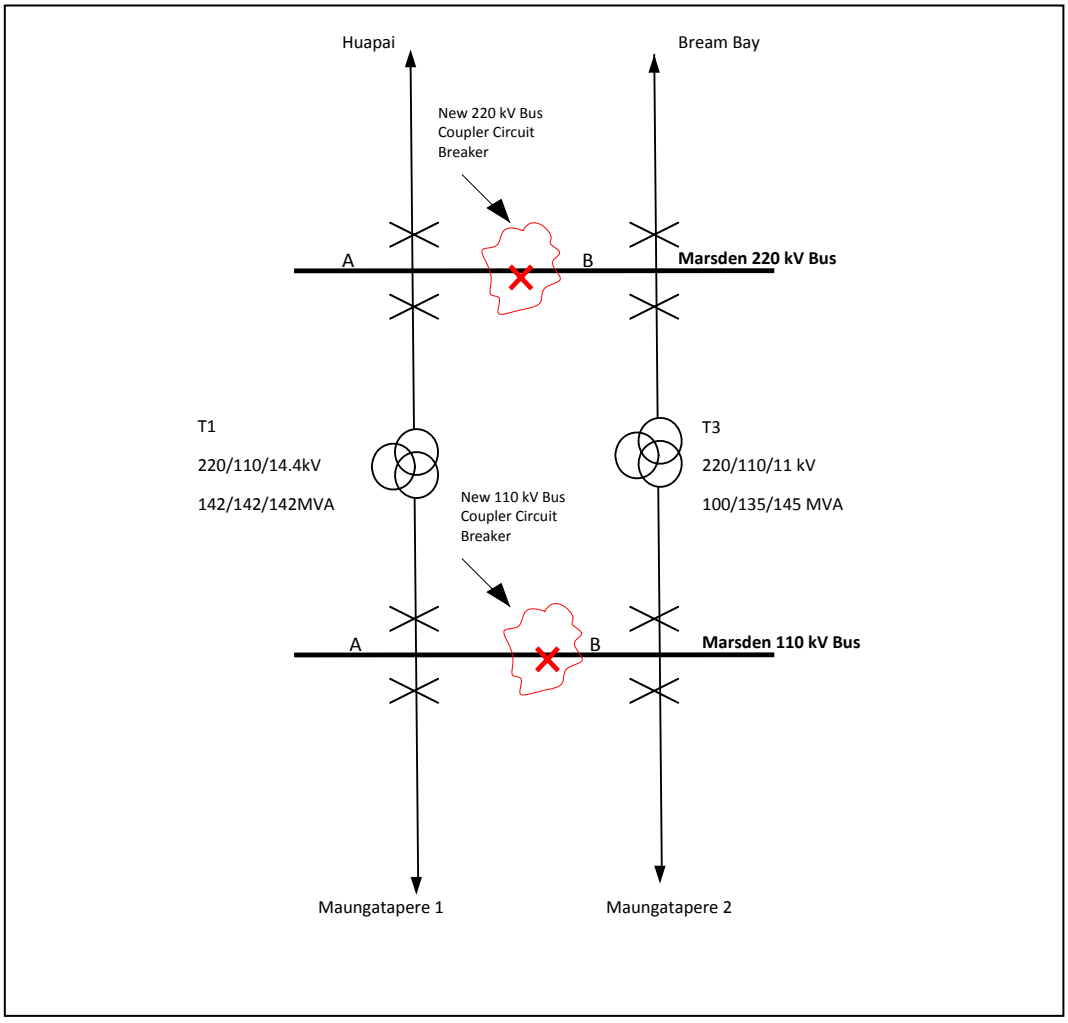
Term	Description
Alternative Project	Projects that are reasonable to consider as alternatives to the proposed investment in applying the Grid Investment Test, in accordance with rule 19, Schedule F4, Part F Section III, Electricity Governance Rules.
APR	**A**nnual **P**lanning **R**eport
Expected costs	Expected costs represent the estimated cost plus a contingency for scope accuracy. Scope accuracy allows for unexpected variations in the design scope and a standard allowance, based on experience, for items not considered in the design. Expected costs are in current dollars and do not allow for cost uncertainty related to price variations, inflation, or financing costs.
expected unserved energy	A forecast of the aggregate amount by which the demand for electricity exceeds the supply of electricity at each grid exit point as a result of likely planned or unplanned outages of primary transmission equipment.
GEIP	**G**ood **E**lectricity **I**ndustry **P**ractice.
GEM	**G**eneration **E**xpansion **M**odel, a model for generation expansion modelling developed by the Electricity Commission.
GIT	**G**rid **I**nvestment **T**est. A cost-benefit analysis for both reliability and economic investments. The specific rules defining the Grid Investment Test, as developed according to the process in rule 6 of section III, are set out in Schedule F4 of section III of Part F.
GPS	**G**overnment **P**olicy **S**tatement on Electricity Governance.
GUP	**G**rid **U**pgrade **P**lan. A plan for grid expansions, replacements and upgrades, developed in accordance with rule 12 of section III of part F, Electricity Governance Rules.
HVAC	**H**igh **V**oltage **A**lternating **C**urrent
HVDC	**H**igh **V**oltage **D**irect **C**urrent
MAC	Maximum Approval Cost
modelled projects	Transmission augmentation projects and non-transmission projects, other than the proposed investment and alternative projects, which are likely to occur in a market scenario, are reasonably expected to occur in that market development scenario within the time horizon for assessment of the market benefits and costs of the proposed investment and alternative projects, and the likelihood, nature and timing of which will be affected by whether the proposed investment or any alternative project proceeds.

Monte Carlo	Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of numbers randomly generated within certain ranges as inputs. It creates a distribution of possible outcomes on which descriptive statistics can then be run.
P90 cost	Estimated 90th percentile of project costs.
reliability investment	Investments by Transpower in the grid, or alternative arrangements by Transpower, the primary effect of which is, or would be, to reduce expected unserved energy.
Rules	The Electricity Governance Rules 2003. In the context of this document, it generally refers to Part F Transport, Section III Grid Upgrade and Investments.
Transpower	Transpower New Zealand Limited, owner and operator of New Zealand's high-voltage electricity network (the National Grid).

Appendix B Bus Configuration with Bus Couplers

The figure below shows the network schematic of the Marsden 220 kV and 110 kV buses with the bus couplers. For simplicity, the ring-bus configuration is not shown.

Appendix Figure 1: Simplified future Marsden 220 kV and 110 kV bus configurations



Appendix C Maximum Approved Cost Methodology

This application seeks Commission approval to recover the lesser of actual costs or the estimated Maximum Approved Cost (MAC) of the Proposal.

The Expected Cost of the Proposal, as used in the GIT, is estimated to be $5.7 million and the MAC of the Proposal is estimated to be $6.5 million. This section sets out how Transpower has estimated the MAC and describes the difference between the Expected Cost and the MAC.

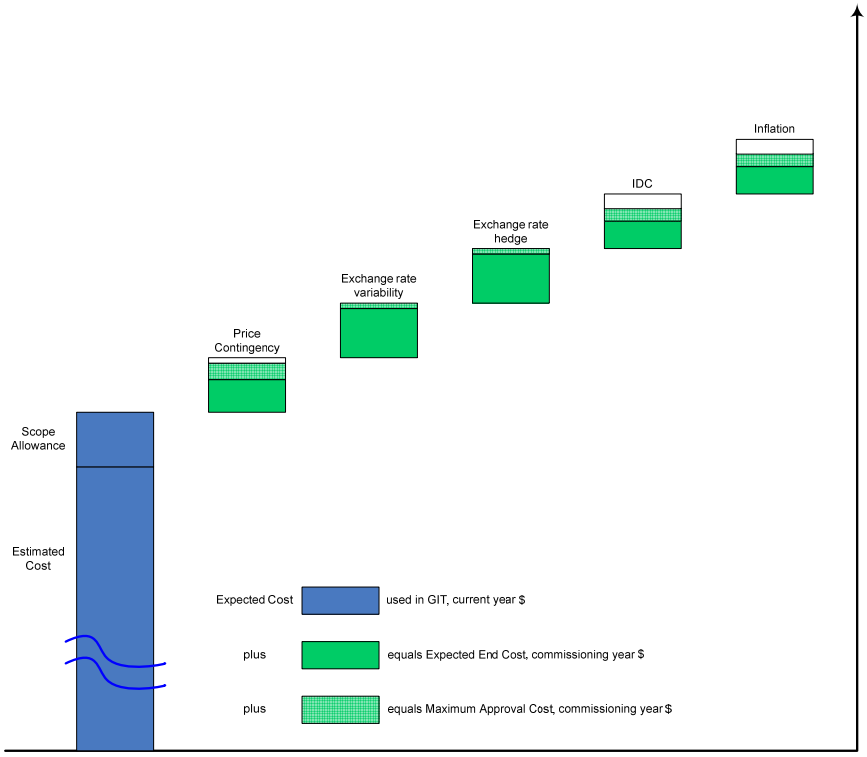
In previous investment proposals submitted to the Commission, Transpower has sought approval to recover up to a P90 cost. It is expected there is only a 10% probability that the P90 figure would be exceeded once the Proposal was commissioned. The P90 figure was derived from a probabilistic analysis of the expected cost of the Proposal using a Monte Carlo approach.

However, experience has shown that the development of a P90 figure lacks transparency and in particular it is difficult to relate the P90 cost back to actual, trackable, project specific costs.

Transpower has therefore applied a different method for the Marsden Substation Investment Proposal and has determined a MAC. The methodology for determining a MAC is described below.

For comparison, Transpower has also calculated and reported a P90 figure in order to assist the Commission understand how the new approach for calculating a maximum approval amount relates to the previous approach.

The relationship between the Expected Cost used in the GIT and the MAC is represented in Appendix Figure 2.



Appendix Figure 2: – Relationship between Expected Cost and MAC[10]

The approval amount is higher than the Expected Cost used in the GIT because:

- The Expected Cost comprises an estimated cost plus an allowance for scope variations. It does not include an allowance for all uncertainties present in a construction project of the type proposed.
- The Expected Cost is in current (today's) dollars, whereas the approval amount is an estimate of the end cost of the project in future (commissioning year) dollars.
- The approval amount is required to cover the full cost of the project including financing costs, price variations on materials, exchange rate variations and foreign exchange hedging, etc.

Importantly at the approval stage the actual costs are known at a high level only as such things as transformer suppliers are yet to be determined and there is also a reasonable time gap between approvals and when the majority of actual costs are incurred.

Appendix Figure 2 shows that the Expected Cost used in the GIT is the Estimated Cost plus Scope Allowance only, in current year dollars.

The Maximum Approved Cost is higher than the Expected Cost because it includes an allowance for price contingencies and all other variables. Estimates are used to produce an overall MAC similar in magnitude to the previously calculated P90.

Method of calculating Maximum Approval Cost

The following inputs and variables are considered in deriving the Expect Cost and MAC:

- **Estimated Cost.** The Estimated Cost is the estimated cost of designing, procuring, constructing and commissioning the components which make up the Proposal. These costs can include decommissioning costs and the costs of obtaining designations,

[10] Exchange rate variations are based on historical volatility and estimated on a 90th percentile likely over the period between the Reference Date (used for calculating costs used in the GIT) and when tenders might be accepted.

easements, resource consents and property purchases for these works if applicable. The Estimated Cost does not include contingencies. The Estimated Cost is in current dollars, as calculated on the Reference Date.

- **Reference Date.** Transpower prepared estimated capital costs as at 14 May 2009. A reference date is used to ensure consistency between the estimated capital costs of components within each option considered in the GIT and between options. For calculating costs at commissioning time, Transpower has assumed a commissioning date of 1 April 2010. These commissioning dates are assumed to be the dates at which accumulated costs for the project would be included in Transpower's regulated asset base and from which costs would start to be recovered through the Transmission Pricing Methodology.
- **Scope allowance.** Transpower also estimates a scope allowance, which is added to the Estimated Cost, to cover two distinct categories of costs:
    a) costs for works which are planned, but which have not been included in the estimated capital costs except through this general allowance, and
    b) costs for works not anticipated at the time costs were estimated. The Estimated Cost plus Scope Allowance equals the **Expected Cost** of the project or various components of it and this is the cost used in GIT analyses. The Scope Allowance is treated as a fixed percentage of Estimated Costs which are added to the Estimated Cost.
- **Price Contingency.** As regulatory approval occurs prior to the issuing of tenders, there is uncertainty over the price of equipment to be installed. In particular, this includes the risks that:
    - market pressures may affect the cost of capital items, e.g. if worldwide demand for transformers is high at the time Transpower seeks tenders, the prices offered may reflect a tighter supply situation and therefore be higher than at other times; and
    - commodity price movements. Tender prices for some capital items include escalators linked to market price variations in significant elements of that item e.g. metals such as steel and copper. As with exchange rate variations, Transpower would not, typically, consider hedging anticipated commitments until a contract is awarded/signed. This is because of the somewhat speculative nature of entering commodity futures contracts in advance of commitment and the costs involved, which may or may not be required, depending upon the terms of the eventual contract. Hence, Transpower is exposed to commodity price movements up until contracts are signed and so an estimate is made of the potential cost variation this might cause.

  Price movements could be downward as well as upward and for this reason the price contingency is estimated as the minimum and maximum variations expected. A price contingency of -5% to +20%, would be typical. The MAC costs are based on a cost estimate derived in May 2009.

  For the purposes of calculating the Expected End Cost, the mean of this range is taken i.e. 5% for the example above.

  For the purposes of calculating the MAC, the 62nd percentile of this range is taken i.e. 6.3% for the example above.
- **Exchange rate variations.** Transpower's current practice is to enter foreign exchange contracts to hedge foreign exchange movements, once contractual commitments are made. This provides NZ dollar cost certainty from the point that tenders are awarded/contracts signed.

  Transpower does not, typically, hedge anticipated commitments. This is because of the somewhat speculative nature of entering foreign exchange contracts in advance of commitment and the added costs of having to pay option premiums for hedging a range of possible currencies and execution dates, most of which would not be exercised. Hence the requirement to estimate the effect on costs of exchange rates moving in the interim period before signing contracts.

The Estimated Costs were based on average exchange rates around the Reference Date. For the purposes of calculating the MAC, the Proposal cost reflected a USD exchange rate of 0.4923.

The exchange rate variations are based on historical volatility and are estimated on either a 90th or 70th percentile likely over the period between the Reference Date and when tenders might be accepted. The methodology used to calculate the 90th and 70th percentile volatility variations is as developed by Bancorp and as used for the HVDC Proposal.

Exchange rate hedge. As mentioned above, Transpower's current practice is to enter foreign exchange contracts to hedge foreign exchange movements, once contractual commitments are made. However, for smaller projects Transpower may elect not to hedge these risks. This is the case for the Proposal. As a result, hedging costs for both the Expected End Cost and MAC are zero.

- **Real interest rates**. Real interest rates are used in the calculation of Interest During Construction costs and are assumed to vary between 3.3% and 5.3%, as 10th and 90th percentiles respectively, with a mean of 4.3%. The nominal interest rate is the real interest rate plus the inflation rate, equating to a mean nominal interest rate of 7.3% in this instance. This is approximately Transpower's current cost of debt.

  For the purposes of calculating the Expected End Cost and MAC, the mean of 4.3% is used.

- **Inflation**. Transpower assumes inflation will vary between 2% to 4% per annum, as 10th and 90th percentiles respectively, with a mean of 3%.

  For the purposes of calculating the Expected End Cost and MAC, the mean of 3% per annum is used.

Results of Expected Cost, Expected End Cost and MAC calculations

The Expected Cost of the Proposal, as estimated in May 2009, is $5.7 million.

This cost includes a scope allowance and represents Transpower's estimate of the cost of designing, purchasing, constructing and commissioning the Proposal, in current dollars. Transpower will not start recovering the costs of a stage of this Proposal until it is commissioned, i.e. April 2010. The cost Transpower will look to recover at that time is higher, due to potential cost uncertainties, financing costs incurred throughout the construction period and inflation.

The Expected End Cost of the Proposal includes a price contingency, exchange rate variability allowance, the expected cost of foreign exchange hedging, inflation and Interest During Construction costs. For the purposes of calculating an Expected End Cost, all parameters (e.g. inflation) are assumed at their 50th percentile levels. This gives an Expected End Cost akin to a P50. The Expected End Cost for the Proposal is $6.3 million.

The MAC for the Proposal is calculated using upper percentile estimates for the various parameters and results in a MAC of $6.5 million. Transpower is seeking approval to recover the lesser of actual costs or the MAC.

There is a probability of exceeding the MAC (and in fact as shown below, the MAC is close to a P90 figure). If there are changes which are materially different to those assumptions used in deriving the MAC then this cost may be exceeded. In such a case, Transpower would apply for approval for the revised costs of the project in accordance with Rule 17.2.

Appendix Table 1 shows the break down of the MAC.

Appendix Table 1: Maximum Approval Cost for the Proposal, $ million

$NZ million	Estimated Cost	Expected Cost	Price contingency	Exchange rate variability	Inflation	IDC	TOTAL
Expected Cost	5.2	5.7					5.7
Expected End Cost	5.2	5.7	0.3	-	0.2	0.1	6.3
Maximum Approved Cost	5.2	5.7	0.4	0.1	0.2	0.1	6.5

For comparison, Transpower has calculated a P90 figure for the Proposal, using the same approach as use for past GUPs. The MAC and P90 are shown in Appendix Table 2 below:

Appendix Table 2: Maximum Approval and P90 Costs, $million

MAC	P90
6.5	6.5

Summary of estimated Expected End Cost and Maximum Approval Cost

Transpower estimates the Expected End Cost, with variations accounted for, to be $6.3 million and the Maximum Approval Cost of the Proposal is $6.5 million in $2009.

