RULE CHANGE PROPOSAL

August 2008

Disconnected nodes

This paper proposes various rule changes relating to disconnected nodes to ensure the System Operator's new market systems are strictly compliant with the rules and to improve rule clarity and correctness.

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TABLE OF CONTENTS

1 Purpose

This paper describes issues relating to the disconnected nodes functionality to be implemented in the System Operator's new market systems as part of its Market Systems Project (MSP).

There are differences between the functionality currently used and that which will be implemented as part of MSP. These differences and the associated obligations in the Electricity Governance Rules (EGRs) are discussed in this paper.

The System Operator proposes a (minor) rule change to avoid its new market systems being out of compliance with the EGRs. The System Operator also proposes rule changes that are not specifically related to the new market systems, these being intended to improve rule clarity and correctness.

2 Executive Summary

2.1 Improvements relating to disconnected nodes under the new market systems.

In summary, we believe the proposed new market systems disconnected nodes functionality improves on the status quo, as follows:

- an issue with the current pricing of disconnected nodes is that SPD calculates values ranging anywhere between -$100,000/MWh and +$100,000/MWh. These "infeasible" values are published directly to participants from the PDS, SDPQ and RTP schedules
- nodes are flagged as disconnected in the PDS and SDPQ but not in RTP[1]. Whether or not such a flag is provided, however, the values published are potentially confusing. They provide a poor indicator of the final price at these nodes; the Pricing Manager sets the final price at all disconnected nodes to zero prior to final prices being published
- under MSP, SPD will automatically set the price at disconnected nodes to zero for all schedule types. Zero prices will therefore be published to participants for disconnected nodes in the PDS, SDPQ, RTP and final pricing schedules. This facility will reduce work required by the Pricing Manager
- this will reduce the current potential for confusion, and provide a better indication to participants of the price that will apply for settlement purposes.

2.2 Differences in implementation

The criteria of what constitutes a "disconnected node" does not change in the new market systems. However, due to differences in implementation there is a rare scenario where nodes that currently do not meet the criteria will meet the criteria under MSP. The System Operator proposes a rule change to meet that situation.

[1] The consultation paper published by the Electricity Commission titled "Instantaneous Reserves Pricing and Dispatch" (20 February 2006) contained a proposed rule amendment to require the System Operator to identify disconnected grid injection points and grid exit points as part of RTP publication.

2.3 Proposed rule changes

The System Operator proposes rule changes that fall into three categories:

(i.) Changes (minor in nature) that we believe are necessary in order for the new market systems (specifically, the implementation of disconnected nodes functionality) to be strictly compliant with the rules. This is sought because of MSP.
(ii.) Changes to provide greater clarity about how disconnected nodes are identified and priced. This is not required because of the MSP.
(iii.) Changes to correct an existing flaw identified with rule G V 3.27A. This is not required because of the MSP.

The System Operator intends to apply for a rule exemption that would cover point (i). The exemption application will request an exemption for the period from the actual go-live of the new market systems until a rule change comes into effect.

3 Background – obligations in respect of disconnected nodes

3.1 System Operator obligations

The System Operator is required to identify grid injection points (GIPs), grid exit points (GXPs) and points of connection to the grid that are disconnected under the following rules:

- G III 10.2.3 (System Operator publishes disconnected GIPs/GXPs in the PDS)
- G III 10.4.8 (System Operator publishes disconnected GIPs/GXPs in the SDPQ)
- J 6.1 (System Operator notifies Reconciliation Manager of disconnected points of connection to the grid).

The word "disconnected" is an undefined term in the EGRs. In practice, the interpretation the System Operator currently uses when fulfilling its obligations under these rules is as follows:

Disconnected nodes[2] are nodes in the SPD model that are within an electrical island where there is zero cleared generation and zero load.

Thus the System Operator's interpretation of "disconnected" in this context is based on physical disconnection in the SPD model. The System Operator does not take account of price when determining whether a node is disconnected.

The System Operator's interpretation is one of long standing and has existed since before the start of the EGRs.

3.2 Pricing Manager obligations

The Pricing Manager is required, under rule G V 3.27A, to assign a zero price to GIPs and GXPs where the software used to calculate final prices identifies a "disconnected price situation" has occurred.

Disconnected price situation is a defined term in part A of the EGRs. The definition specifies that:

[2] A node represents a physical bus that may or may not be associated with a GIP or GXP.

- the relevant GIP/GXP is physically disconnected (it must have no generation or load and be disconnected from the network); and
- the software has substituted the price at the GIP/GXP with the constraint violation penalty (CVP) for deficit bus generation or surplus bus generation. This value is $100,000 /MWh.

4 Differences between current and new market systems functionality

Section 4 describes the new market systems concept of “live” and “dead” nodes.

4.1 Summary of live and dead island scenarios

Figure 1 summarises which electrical island scenarios are live and dead.

Scenario	The island has….		Live/Dead Island (TOPPER's[3] definition)	Comment
	Generation node(s)	Load node(s)		
A	Y Cleared generation	Y Load	Live	
B	Y Cleared generation	Y Zero load	Live	E.g. Generation cleared to supply fixed losses on a transformer.
C	Y Cleared generation (present) Zero generation cleared (MSP)	N Null load	Dead	E.g. Generation cleared to supply fixed losses on a transformer. In the new market systems, zero generation will be cleared because the island is dead. All nodes in the island will be identified as disconnected.
D	Y Zero generation cleared	Y Load	Live	Only possible if zero generation was offered. An infeasibility situation occurs at every node in the island where there is unserved/negative load.
E	Y Zero generation cleared	Y Zero load	Live	All nodes in the island are disconnected.
F	Y Zero generation cleared	N Null load	Dead	All nodes in the island are disconnected.
G	N Null generation	Y Load	Dead	An infeasibility situation occurs at every node in the island where there is

[3] See 4.3 below.

	The island has….			
				unserved/negative load.
H	N Null generation	Y Zero load	Dead	All nodes in the island are disconnected.
I	N Null generation	N Null load	Dead	All nodes in the island are disconnected.

Figure 1 - Table showing which island scenarios are live and dead. Y/N indicates a physical generation or load connection point does/does not exist.

4.2 Current functionality

Figure 2 shows the current price determination process.

Currently all GIPs and GXPs are provided as an input to the SPD market clearing solver, which calculates prices. Disconnected nodes are identified after SPD has completed it's solve, by calculations external to SPD. The only schedule type for which disconnected nodes are assigned a zero price is final pricing. The pricing manager does this via the PME program.

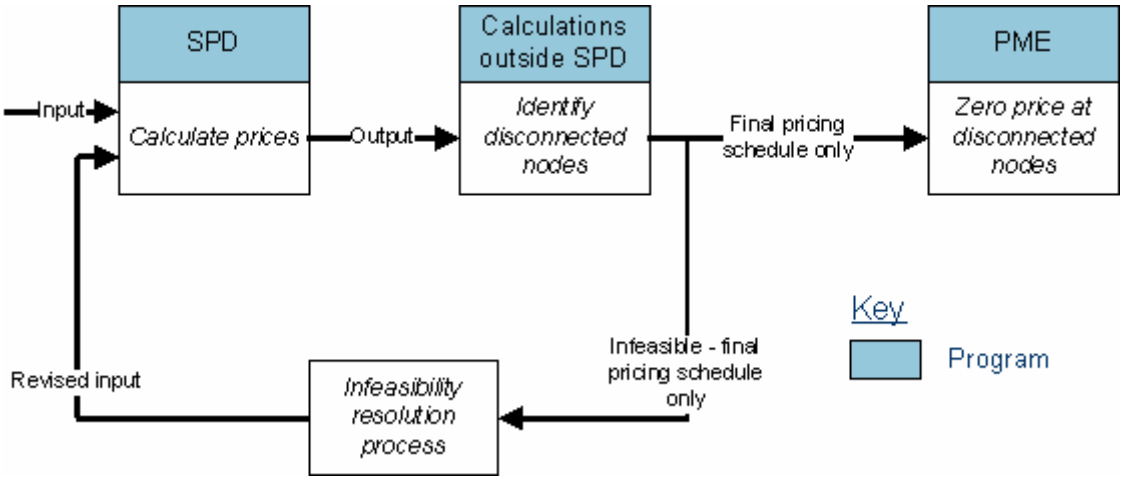


Figure 2 - Current price determination process

4.3 MSP functionality

Figure 3 shows the new market systems price determination process.

The Topology Processor, or TOPPER, is the first step in the SPD scheduling process. TOPPER identifies the offered grid and creates a network topology for every trading period for input into SPD. As part of this, TOPPER identifies "dead" nodes that are defined as follows.

Dead nodes are nodes within an electrical island where no physical generation connection point exists, or no physical load connection point exists, or neither exists[4].

[4] TOPPER does not take into account what the generation or load quantity is at the connection point. TOPPER will identify that a connection point exists even if the quantity at the connection point is zero.

In order to reduce SPD solver time, dead nodes will be excluded from the SPD market clearing solver, which calculates prices. SPD will assign prices to dead nodes during post-processing that occurs after the solver finishes.

The price assigned to dead nodes will, in most cases, be the same as that which would result during, or at the end of, the current price determination process. Dead nodes that are disconnected will be assigned a zero price[5]. Dead nodes at which there is unserved/negative load will be assigned the CVP value for deficit/surplus generation, and SPD will identify that an infeasibility has occurred.

The pricing of dead nodes is discussed in further detail in section 5.

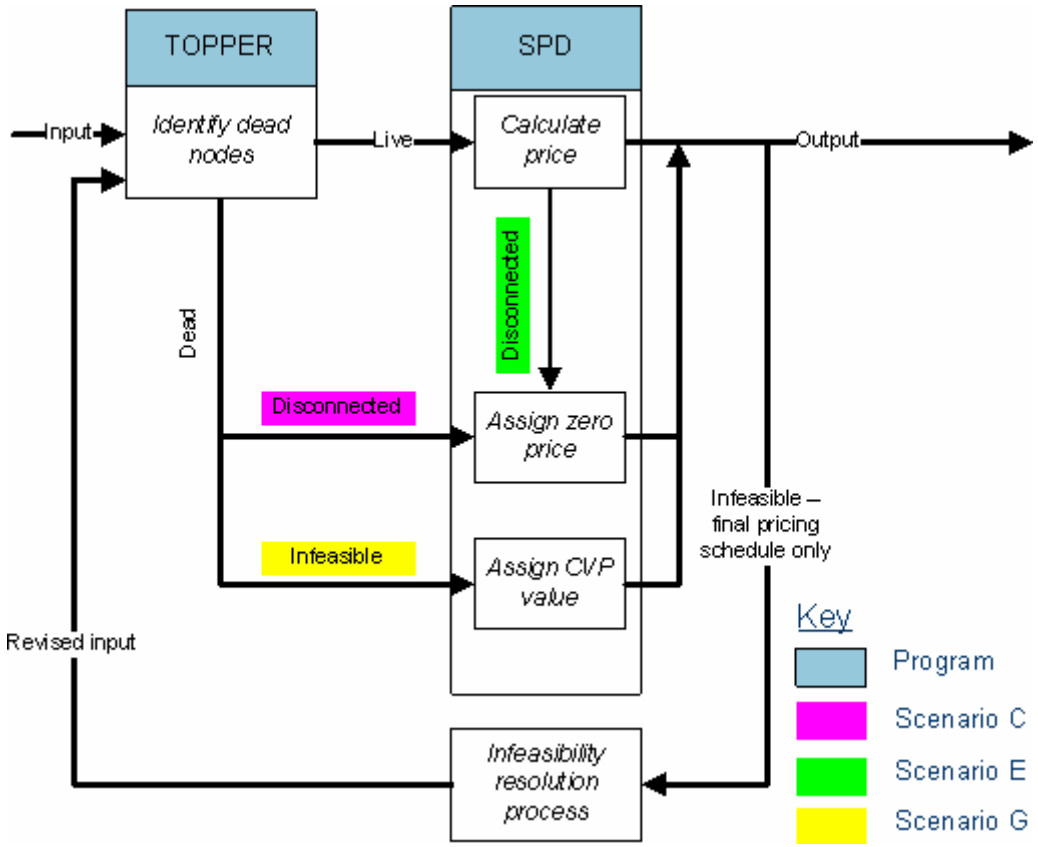


Figure 3 - MSP price determination process (all schedule types). The island scenarios discussed in later sections of this paper – C, E and G – are as marked.

4.4 Differences

In summary, under the new market systems:

- disconnected nodes will be assigned a zero price in all schedule types. Currently this is done for the final pricing schedule only
- disconnected nodes will be assigned a zero price automatically within SPD. Currently the Pricing Manager uses a program outside SPD to do this
- some nodes (dead nodes) will no longer have prices calculated by the SPD market clearing solver. SPD will assign prices to these nodes in post-processing
- there are two scenarios where dead nodes would currently not be identified as disconnected. The price assigned could potentially differ to the price that would currently be calculated by SPD (scenarios C and G).

[5] This applies to all schedule types, rather than just in the final pricing schedule, as currently occurs.

5 Pricing of dead nodes

5.1 Nodes that are dead but are not currently identified as disconnected

The definitions of dead and disconnected nodes are very similar. In general, nodes that will be categorised as dead would currently be considered disconnected. The final price outcome for these nodes will be the same as the current outcome (zero).

There are two scenarios where nodes that are dead would not currently be identified as disconnected:

Scenario G[6] There is no cleared generation within the island but some load. This is an infeasibility situation.

Scenario C[7] There is some cleared generation within the island but no load. This could occur either because there are fixed losses within the island or if there is a surplus generation infeasibility due to binding ramp rate constraints.

Examples of these scenarios are provided in the appendix.

5.2 Scenario G

Currently if scenario G occurs, the SPD market clearing solver uses a CVP for all nodes within the island. SPD reports an infeasibility has occurred at nodes where there is unserved/negative load (including fixed losses as "load").

In the new market systems, SPD will assign a zero price to all nodes within the island except for nodes where there is un-served/negative load, which will be assigned the CVP value for deficit/surplus generation. As currently occurs, scenario G nodes will not be identified as disconnected. SPD will report a deficit/surplus generation infeasibility has occurred at nodes where there is un-served/negative load (excluding fixed losses).

The infeasibility resolution process ensures that all deficit and surplus generation infeasibilities are resolved in the final pricing schedule prior to final prices being published.

5.3 Scenario C

We refer to examples C1 and C2 provided in the appendix.

Currently scenario C nodes would have a price calculated by the SPD market clearing solver. They would not be assigned a zero price because they would not be identified as disconnected.

The new market systems version of SPD will identify scenario C nodes as both dead and disconnected. It will exclude these nodes from its market clearing solve and assign a price of zero. No infeasibility will arise because no generation will be cleared by the new market systems solver at these nodes (example C2).

[6] Refer figure 1.
[7] Refer figure 1.

The new market systems approach to treating scenario C nodes is appropriate for the following reasons:

- an island that does not have any GXP load is for all intents and purposes genuinely disconnected
- in reality a generator would currently not be expected to generate solely to supply fixed losses (example C1). In the new market systems, the dispatch schedule will not clear any generation at scenario C nodes so none will be dispatched. Thus it is unlikely any reconciliation volumes would be submitted at scenario C nodes
- there are no known cases where example C2 has actually occurred in final pricing[8].
- in any event, if example C2 did occur in final pricing, the new market systems outcome is appropriate given the generator is not connected to any GXP load
- no change is required to the SPD formulation to enable the change to the way SPD treats these nodes, as discussed further below.

We note this approach is consistent with the interpretation of "disconnected" (as noted above) that the System Operator has historically used and currently uses in fulfilling its Part G obligations. The criteria themselves have not changed; scenario C nodes will change from not meeting the criteria to meeting the criteria due to the implementation differences described.

The System Operator proposes a rule change, to Part A of the EGRs, to provide rule clarity as to the System Operator's interpretation of "disconnected".

5.4 Rule exemption from applying constraints at dead nodes

Rules 3.1 and 3.2 of schedule G6 of the EGRs require the modelling system (SPD) to form constraints based on the offers, bids and ramp rates submitted.

The System Operator will apply for an exemption from these rules in respect of dead nodes. These rules will not be met at dead nodes because dead nodes will be excluded from the SPD market clearing solver and no constraints will be applied.

No bids or offers will be cleared at dead nodes. Hence the requirements of the bid and offer constraints (to ensure the bid or offered quantity is not exceeded) will be satisfied even though the constraints are not actually applied.

In the System Operator's view in most cases the ramp rate constraints, if applied, would also have no effect on the schedule results[9]. The scenario where the constraints would bind (example C2) appears very unlikely to occur. In any event, it is appropriate to treat such nodes as disconnected given there is no GXP load connected to these nodes.

Given the long term nature of this issue, the System Operator proposes a rule change to supersede the rule exemption being sought.

5.5 No change to SPD formulation

By identifying dead nodes, TOPPER will reduce the input information provided to the SPD market clearing solver to a subset of what is currently provided. The input information at dead nodes will be provided directly to SPD post-processing.

[8] Records were checked from 1 March 2004 to 20 July 2008.
[9] See also the view of PA Consulting Group (paragraph 3) in that firm's letter dated 5 August 2008 (page 18, below).

The SPD formulation specifies how SPD processes input information it receives. It does not specify what input information is provided to the solver; the input information changes constantly. Thus, changing the solver input information to exclude dead nodes does not require a change to the SPD formulation.

The SPD formulation specifies how the price at live nodes should be determined. It does not specify what the price at dead nodes should be.

6 Pricing of disconnected nodes that are not dead

6.1 Pricing of scenario E nodes

As shown in figure 3, nodes that are disconnected but not dead (scenario E) will have prices calculated by the SPD market clearing solver. In post-processing, SPD will assign a zero price.

6.2 No change to SPD formulation

In theory, the nodal price at a disconnected node is undefined and there are multiple pricing solutions. The nodal price could lie anywhere between plus or minus the CVP (±$100,000/MWh).

In practice, the price calculated by the SPD market clearing solver depends on the particular solver algorithm used. The algorithm used in the MSP solver could calculate prices for scenario E nodes that fall anywhere within the theoretical range of values for disconnected nodes[10]. Regardless of any intermediate value used, SPD will assign a zero price to all disconnected nodes (live or dead) in all schedule types.

This differs from the status quo, under which only disconnected nodes in the final pricing schedule are assigned a zero price (by the Pricing Manager, as required by rule G V 3.27A).

Given the price at disconnected nodes is theoretically undefined, SPD can be changed to price disconnected nodes at zero without changing the SPD formulation.

To provide clarity in the rules as to how disconnected nodes are priced, the System Operator proposes rule changes that would require a zero price to be assigned to all GIPs/GXPs that are disconnected in the PDS, SDPQ and RTP. Such a rule change would create a binding requirement for future versions of SPD to price disconnected nodes in the same way.

7 Existing flaw in G V 3.27A

To clarify the way in which the new market systems version of SPD will behave, we point out an existing flaw with the wording of rule G V 3.27A.

In order for a zero price to be assigned to a disconnected node, rule G V 3.27A specifically requires SPD to have calculated a value at that node equal to the CVP ($100,000/MWh). However, as described above, SPD could potentially

[10] This is also the case for the current solver. We note the current solver generally "chooses" prices of ±$100,000/MWh, or $0/MWh in these situations.

calculate a value anywhere within the range of -$100,000/MWh to +$100,000/MWh at a disconnected node.

We understand the Pricing Manager's current process is to assign a zero price to all nodes that are disconnected, irrespective of the price calculated by SPD. Thus, the new market systems version of SPD will align with current practice in this regard, even though current Pricing Manager practice can be argued to be technically inconsistent with G V 3.27A.

The System Operator proposes a rule amendment to correct this apparent flaw.

8 Summary and conclusions

- In summary, the System Operator believes the way disconnected nodes will be treated in the new market systems is an improvement on the status quo because:
  - there will be a consistent approach to how disconnected nodes are priced across all schedule types
  - the current potential for confusion arising from "infeasible" prices being signalled at disconnected nodes will be removed
  - the PDS, SDPQ and RTP will provide a more accurate indication of the final prices at disconnected nodes
  - SPD will automatically assign a zero price to all disconnected nodes instead of a separate Pricing Manager program outside SPD.

- The new market systems implementation distinguishes between live and dead nodes. SPD will identify deficit and surplus generation infeasibilities at dead nodes where there is un-served/negative load, consistent with the current identification of infeasibilities.

- Whilst there is no change to the criteria for being "disconnected", there is a rare scenario (scenario C) where dead nodes that do not, in the current pricing process, meet the criteria for being disconnected will meet the disconnected criteria under MSP. This change is expected to have a negligible, if any, impact on participants and is within the intent of the EGRs.

- The System Operator has identified the rule requirements to apply bid, offer and ramp rate constraints at dead nodes will technically not be met under the new market systems. The System Operator therefore believes a rule change is necessary in order for the new market systems to be strictly compliant with the rules. Not applying these constraints at dead nodes is expected to have a negligible, if any, impact on participants and is within the intent of the EGRs.

- The System Operator proposes rule changes to:
  a) remove the requirements to apply constraints at dead nodes
  b) improve clarity in the rules about how disconnected nodes are identified and priced; and
  c) correct an existing flaw identified with rule G V 3.27A.

- The System Operator will seek an exemption from the requirements to apply constraints at dead nodes. The System Operator believes it would be desirable to expeditiously progress rule change (a) to supersede the rule exemption. Rule change (b) would improve clarity and create a binding requirement for future versions of SPD to price disconnected nodes in the

same, improved, manner. Rule change (c) addresses a discrepancy between the rules and actual practice that currently exists, and that would continue under the new market systems.

9 Proposed Rule Changes

Transpower proposes the Electricity Governance Rules 2003 (EGRs) be changed as follows:

Note: The changes below are "marked up" against the existing wording of the EGRs so the extent of the amendments is identifiable.

1. Changes to remove the requirements to apply bid, offer and ramp rate constraints at dead nodes

Rule reference	Recommended change	Comment
New rule for section G6 3	Notwithstanding rules 3.1 and 3.2, the modelling system will not form constraints within **dead islands**.	
New definitions part A	**"dead island"** means, in relation to the modelling system described in schedule G6, an electrical island where no physical generation connection point exists, or no physical load connection point exists, or neither exists;	The use of the word island in the term "electrical island" has a different meaning to the part A definition of "island", which means the South Island or North Island of New Zealand. There is already a defined term "point of connection". However, this refers to flows both into and out of the grid, local network or embedded network. The definition of "dead island" needs to differentiate between generation connection points and load connection points.

2. Changes to improve clarity and correct rule G V 3.27A

Rule reference	Recommended change	Comment
G V 3.27A	The **pricing manager** must assign a **final price** of $0.00 to all **grid injection points** and **grid exit points** ~~where~~ that ~~the **software** used by the **pricing manager** to calculate **final prices** has identified~~ are ~~**disconnected price situation**~~ **disconnected**.	

Rule reference	Recommended change	Comment
New definitions part A	**"disconnected"** means, in relation to a **grid injection point**, **grid exit point** or **point of connection** for the purposes of part J, that there is zero cleared generation and zero load in the electrical island to which the **grid injection point**, **grid exit point** or **point of connection** is connected in the model;	The "model" refers to the model in the software used to produce prices.
Definition of disconnected price situation, part A	*Recommend no change to this definition unless the definition of infeasibility situation is revised.*	In part G this definition is used in G V 3.27 A, and part A definition of itself and of infeasibility situation.
Definition of infeasibility situation, part A	*Recommend leaving this definition as is.*	While the definition is not very well worded, no change is necessary to reflect the treatment of scenario G as infeasible. For scenario G there will still be a non-zero variable associated with deficit generation. The difference is the non-zero value will be assigned through post-processing rather than being calculated by the SPD solver.
G III 10.2.3	The **grid injection points** and **grid exit points** that are **disconnected** and the **grid injection points** and **grid exit points** where an **infeasibility situation** has occurred.	Change bolds "disconnected".
G III 10.4.8	**Grid injection points** and **grid exit points** ~~where they have been~~ that are **disconnected** or where an **infeasibility situation** has occurred.	Change bolds "disconnected".
J 6.1	No later than two hours after the **publication** of the **final prices** for any **consumption period**, the **system operator** must notify the **reconciliation manager** of all **points of connection** to the **grid** in the **consumption period** that were **disconnected**, and all **trading periods** during which each such **point of connection** to the **grid** was **disconnected**.	Change bolds "disconnected".

Rule reference	Recommended change	Comment
G III 3.3	**3.3 Methodology used to prepare the pre-dispatch schedule ~~is in schedule G6~~** In preparing each **pre-dispatch schedule** and set of **forecast prices**, the **system operator** will: 3.3.1 use the methodology set out in schedule G6~~.~~; and 3.3.2 assign a **forecast price** of $0.00 to all **grid injection points** and **grid exit points** that are **disconnected**.	
G III 5.4	**5.4 Methodology used ~~as in schedule G6~~ to prepare dispatch prices, dispatch quantities, dispatch arc flows, dispatch group constraint arc flows, group constraint formulas and HVDC component flows** In preparing **dispatch prices, dispatch quantities, dispatch arc flows, dispatch group constraint arc flows, group constraint formulas** and **HVDC component flows** the **system operator** will: 5.4.1 use the methodology set out in schedule G6; and 5.4.2 ~~will~~ use the **group constraint formulas** that relate to the **dispatch group constraint arc flows;** and 5.4.3 assign a **dispatch price of** $0.00 to all **grid injection points** and **grid exit points** that are **disconnected**.	

Rule reference	Recommended change	Comment
G III 6.3	**6.3 Methodology used to prepare real time prices ~~is in schedule G6~~** In preparing each set of **real time prices**, the **system operator** will: 6.3.1 use the methodology set out in schedule G6~~.~~; and 6.3.2 assign a **real time price of** $0.00 to all **grid injection points** and **grid exit points** that are **disconnected**.	

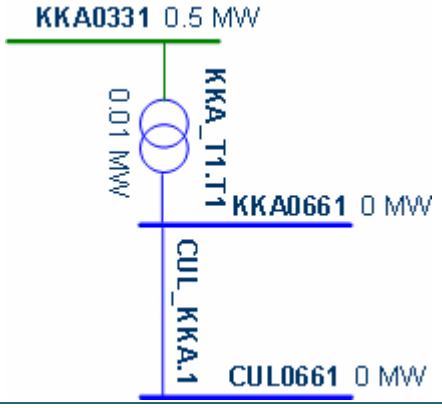
10 Recommendation

It is recommended the Commission supports and progresses this proposed rule change.

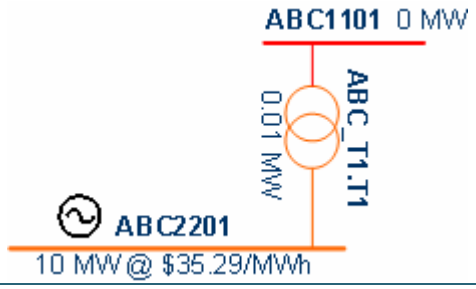
11 Appendix

11.1 Scenario Examples

11.1.1 Example of scenario G

Inputs	
Load at KKA0331 = 0.5 MW No load at KKA0661 or CUL0661 No generation offered Fixed loss for KKA_T1.T1 = 0.01 MW	
Outputs	
Current SPD version	New market systems version of SPD
KKA0331 price = $100,000/MWh KKA0661 price = $100,000/MWh CUL0661 price = $94,376.80/MWh Deficit generation infeasibility at KKA0331 of 0.505 MW Deficit generation infeasibility at KKA0661 of 0.005 MW No infeasibility at CUL0661	KKA0331 price = $100,000/MWh KKA0661 price = $0/MWh CUL0661 price = $0/MWh Deficit generation infeasibility at KKA0331 of 0.5 MW No infeasibility at KKA0661 No infeasibility at CUL0661

11.1.2 Example C1 (scenario C)

Inputs	
No load in the island Offered generation at ABC2201 = 10 MW @ $35.29/MWh Fixed loss on ABC T1 = 0.01 MW	
Outputs	
Current SPD version	New market systems version of SPD
ABC1101 price = $35.31/MWh ABC2201 price = $35.29/MWh Generation cleared at ABC2201 = 0.01 MW ABC1101 and ABC2201 not disconnected	ABC1101 and ABC2201 will be dead buses ABC1101 price = ABC2201 price = $0/MWh No generation cleared at ABC2201 ABC1101 and ABC2201 identified as disconnected

11.1.3 Example C2 (scenario C)

<table>
<tr><td colspan="2">Inputs

No load in the island
Offered generation at XYZ0331 = 34 MW @ $0.01/MWh
Initial MW at XYZ0331 = 33.6 MW
Ramp rate at XYZ0331 = 50 MW/hr</td><td> 
</td></tr>
<tr><td>Outputs
<u>Current SPD version</u>
XYZ0331 price = -$100,000/MWh
Generation cleared = 8.6 MW
Surplus generation infeasibility at XYZ0331 of 8.6 MW</td><td colspan="2"><u>New market systems version of SPD</u>
XYZ0331 will be a dead bus
XYZ0331 price = $0/MWh
No generation cleared at XYZ0331
No infeasibility at XYZ0331
XYZ0331 identified as disconnected</td></tr>
</table>

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//Disconnected nodes.doc

5 August 2008

Mr Dan Twigg
System Operations, Risk & Performance Manager
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Dear Dan

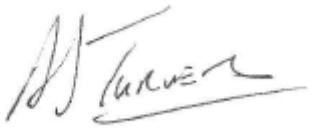
View with respect to changes made to "disconnected nodes" within SPD

You have asked PA, as auditor of SPD under the Electricity Governance Regulations, for our view as to the proposed treatment of disconnected nodes within SPD. We originally examined this issue in 2006 and advised that the changes proposed at that time were acceptable, provided that the agreement of the Pricing Manager with respect to their responsibilities was obtained. I understand that that agreement was obtained at the time.

As requested, I have re-examined the question as to the acceptability of the treatment of disconnected node in terms of Transpower's Rule Change proposal and Application for an exemption from the Electricity Governance Rules 2003 (Rules).

I am able to confirm my earlier advice that the proposed changes to the Rules, and the associated application for exemption, are, in my opinion, within the intent of the Rules, provide a practical software solution to the problem identified in the Rule Change Proposal and should have a negligible, if any, impact on market participants.

Yours sincerely



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