Reliability and Network Planning Panel

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Mr Ian Woodward
The Chairman
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Australian Energy Market Commission
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Dear Mr Woodward

FREQUENCY OPERATING STANDARDS FOR TASMANIA

The Tasmanian Reliability and Network Planning Panel (RNPP) welcomes the opportunity to make a submission on the AEMC Reliability Panel's (Panel) draft determination of Frequency Operating Standards for Tasmania.

Firstly, the RNPP welcomes your adoption of the standards as presently applied in Tasmania as your draft determination and basis for consultation.

The Tasmanian frequency operating standards were first developed in 1999 and have since been annually reviewed by the RNPP in accordance with the Tasmanian Electricity Code. A derogation to the National Electricity Rules provides for these standards, determined by the RNPP, to apply in Tasmania until 29 May 2007. Hence one more review will be undertaken by the RNPP.

In December 2006, the Chairman of the RNPP, Mr Philip Harrington, and an advisor to the RNPP, Mr Peter Clark, presented to the Panel the background to the development and refinement of the Tasmanian standards and the primary constraints in aligning the Tasmanian standards with those for the rest of the interconnected National Electricity Market. I enclose a paper on which that presentation was based for your further consideration.

The RNPP has provided the Panel with a copy of its RNPP's *Frequency Operating Standards for Tasmania – Decision* which includes the issues raised in the two rounds of consultation undertaken by the RNPP and the RNPP's response to each. These standards are also available on the Tasmanian Energy Regulator's website: www.energyregulator.tas.gov.au.

In reaching its decision, the RNPP acknowledged that a number of issues had arisen since Tasmania's entry into the NEM and that it was unable to take into account the impact of the operation of Basslink in the development of the standards. Given the timing of your present review, the Panel may be similarly hampered by a lack of Basslink operational experience.

The RNPP supports the conduct of an additional review within the next twelve months that will include a full cost benefit analysis of any proposal to change the present standards and will draw on experience of the Tasmanian market following a period of Basslink commercial operation.

It has been suggested that Tasmanian standards be aligned with those applied in the rest of the NEM. Alinta Ltd submitted to the RNPP that it would be more costly to construct new thermal and gas turbine generating plant in Tasmania to meet Tasmania's frequency operating standards compared to that incurred in meeting the standard that applies in the rest of the NEM. Further, Alinta stated that a thermal generator's ability to bid into the FCAS market is significantly reduced under wider standards. On the other hand, the RNPP is unable to identify any direct benefits to existing customers in any narrowing of the standards. Such an alignment with NEM standards could impose significant costs on those customers and constrain the operation of the Tasmanian power system. The cost of FCAS under the current arrangements is presently generating considerable concern.

Although the RNPP is required to conduct one more review, it recognises that this process may run in parallel with the Panel's next review. The RNPP will, therefore, continue to liaise closely with the Panel in order to ensure that our processes are not duplicative and produce the best outcome for all stakeholders.

Yours sincerely

Philip Harrington
CHAIRMAN
RELIABILITY AND NETWORK PLANNING PANEL

3 April 2006

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Frequency Operating Standards

Tasmanian Overview

For the Reliability Panel

31 March 2006

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1.0 Purpose

This paper provides an overview of the Frequency Operating Standards for the Tasmanian Power System including:

- background to the development of the present standards; and
- the primary constraints on the alignment of these standards with the standards for the interconnected NEM.

2.0 Background

The RNPP issued the first Operating Frequency Standards in 1999, prior to this the existing parameters for operation of the Tasmanian Power System was the inherited practices of the vertically integrated Hydro Electricity Corporation.

The RNPP made the determination in accordance with the guidelines set by the Tasmania Electricity Regulator which required the RNPP to produce a consultation paper and publicly seek comment from interested parties by submission and/or presentation to the RNPP.

At the time the RNPP recognised that the standards were set substantially wider than those applying in the interconnected NEM system at the time but were close to the standards of the Queensland system which at that stage was not interconnected to New South Wales.

At the time it was also assumed that the Tasmanian electricity supply industry would become part of the National Electricity Market (NEM) and consequently the RNPP took the view that, in setting frequency standards, the definitions and terminology used in the NEM should be adopted in Tasmania.

The 1999 determination for Power System Frequency Operating Standards (Table 1) came into force on 1 January 2000. The standard had provisions so that it did not apply to a part of the Tasmania power system that became “islanded” with the System Controller being required to use reasonable endeavours to maintaining stability in that part of the power system and the provision of a tighter standard to apply to the single generator, other credible contingency and multiple contingency bands in the event of a gas turbine with a capacity greater than 40MW being connected to the Tasmania power system.

Frequency Band	Description	Frequency Standard
Normal Band	Defines the range of frequency control for load fluctuations resulting from the continuous process of switching.	**49.85 – 50.15**
Load change contingency band	Defines sudden and unplanned changes in system load, generally the maximum size of load that is subject to switching.	**49.0 – 51.0**
Single generator contingency band	Defines frequency excursions upon loss of largest generating unit (presently 144 MW).	**47.0 – 51.0** **47.5 – 51.0** [a]
(Other) credible contingency band	Defines the largest load connected on a single circuit (presently 185 MW), and also includes allowable West Coast or Gordon generation while connected via a single circuit (ie during maintenance).	**47.0 – 53.0** **47.5 – 53.0** [a]
Multiple contingency band	Defines the largest frequency excursion where system equipment should, if possible, remain in service.	**44.8 – 55.0** **46.0 – 55.0** [a]

[a] Standard to apply from when the System Controller is satisfied that a single gas turbine powered generator set of a capacity in excess of 40 MW is connected to the system.

Table 1 – 1999 Power System Frequency Operating Standards

In 2002 the Power System Frequency Operating Standards (Table 2) included an amendment to include frequency recovery times following a contingency event. These values were implied in the 1999 determination but not specifically stated.

Frequency band	Frequency range (Hz)		
	Determined Tasmanian standard [a]	Elapsed time to restore frequency to	
		Single Generator Band	Normal Band
Normal band	**49.85 – 50.15**	–	–
Load change contingency band	**49.0 – 51.0**	–	5 minutes
Single generator contingency band	**47.0 – 51.0** **47.5 – 51.0** [a]	–	5 minutes
(Other) credible contingency band	**47.0 – 53.0** **47.5 – 53.0** [a]	60 seconds	5 minutes
Multiple contingency band	**44.8 – 55.0** **46.0** – **55.0** [a]	60 seconds	10 minutes

[a] Standard to apply from when the System Controller is satisfied that a single gas turbine powered generator set of a capacity in excess of 40MW is connected to the system.

Table 2 – 2002 Power System Frequency Operating Standards

The standard has an exclusion for parts of the Tasmanian power system that became “islanded” in so much as the standards would not apply to electrical “islands”. The System Controller was to use reasonable endeavours to maintain stability of the islanded system and restore a satisfactory operating state to the islanded system as soon as practicable.

In March 2003, the RNPP issued a Consultation Paper on Frequency Operating Standards for the Tasmanian Power System and sought comments from Code Participants, interested parties and the public. In the Consultation Paper, the RNPP recommended:

- Changes to align nomenclature used in the standard with nomenclature used in the National Electricity Market (NEM).
- To increase the lower limits of the single generator contingency band (from 47.0 to 47.5 Hz), the other credible contingency band (from 47.0 to 47.5 Hz) and the multiple contingency band (from 44.8 to 46.0 Hz). These changes will facilitate the connection of other generation technologies to the system and support the management of credible contingency events.
- No change to the restoration times contained in the Addendum of June 2002.

The RNPP accepted the NEMMCO suggestion to adopt the summary table as used in the NEM to the extent possible recognising that some differences remain between the Tasmanian standards and NEM standards. The RNPP also decided to adopt the NEMMCO proposal to include accumulated time error in the Frequency Operating Standards and to set the standard at 15 seconds.

To provide adequate time for the System Controller to design and implement the revised load shedding scheme and to re-order Ancillary Service arrangements, the new Frequency Operating Standards (Table 3) applied from 1 August 2004.

Condition	**Tasmanian Electricity Code Glossary 4**	**Containment**	**Stabilisation**	**Recovery**
Accumulated time error		15 seconds		
No contingency event or load event	*normal operating frequency excursion band*	49.75 to 50.25 Hz,	49.85 to 50.15 Hz within 5 minutes	
	normal operating frequency band	49.85 to 50.15 Hz 99% of the time		
Load Event		49.0 to 51.0 Hz	49.85 to 50.15 Hz within 5 minutes	
Generation event		47.5 to 51.0 Hz	49.85 to 50.15 Hz within 5 minutes	
Network event	*Operational frequency tolerance band*	47.5 to 53.0 Hz	49.0 to 51.0 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
Multiple contingency event	*extreme frequency excursion tolerance limits*	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

Table 3 – 2003 Power System Frequency Operating Standards (effective 1 August 2004)

In November 2004 the RNPP completed a review of frequency operating standards and concluded that the standards determined in 2003 for the power system was still appropriate. In response to the consultation paper NEMMCO strongly preferred the RNPP to determine standards for electrical islands. There are many contingency events in the Tasmanian power system that could result in the formation of an electrical island. Not all of these involve a large number of customers, for example, loss of the double circuit Gordon – Chapel Street 220 kV transmission line during maximum output from Gordon Power Station would create an electrical island at Strathgordon. As the load at Strathgordon is extremely small in relation to the maximum output of the power station, the frequency would rise dramatically, and it would be impossible to control frequency to within realistic frequency standards. Therefore it is necessary to define which electrical islands are to be covered by any frequency operating standards for islands. For the purpose of setting frequency operating standards, an electrical island is defined as a significant part of the power system that becomes separated from the remainder of the system due to loss of a connecting element. Consequently, for the first time, the RNPP set frequency standards for electrical islands.

The RNPP also noted that the standards determined in 2003 could not be implemented practically until the new Under Frequency Load Shedding Scheme (UFLSS) and Over Frequency Generator Shedding Scheme (OFGSS) were commissioned. The UFLSS was commissioned in early 2005 and the OFGSS is expected to be commissioned shortly.

NEMMCO's submission to the RNPP identified that to facilitate operation of the system after Tasmania joined the National Electricity Market the standards should be expressed in a form that closely aligns with current NEM standards; this was supported by the RNPP and reflected in its 2004 determination.

The 2005 review of the Standards resulted in a number of changes being made to address issues arising from Tasmania's entry into the NEM and pending interconnection to the mainland:

- The stablisation and recovery time for a load event has been increased from 5 to 10 minutes. This addresses a problem experienced by a major customer due to the 5 minute dispatch interval in the NEM where it was being asked to delay restoration until sufficient ancillary services had been dispatched in the following interval to avoid excessive frequency excursions when the load is switched back in.
- The definition of generation event was amended such that the loss of a transmission line directly connecting a generating unit to the power system is treated the same under the Standards as the loss of the generating unit itself.
- Basslink switching within the constraints of the frequency standards. The issue was raised by NEMMCO with a proposal to modify the Normal Operating Frequency Excursion Band. However the RNPP decided to modify the definition of a "load event" to achieve the same outcome.

3.0 Discussion

3.1 Comparison of the standards:

The present Tasmanian Standards (Attachment 1) stipulate six bands of frequency within which the system frequency must remain for various types of contingencies:

"No contingency event or load event" defines the range of frequency control for load fluctuations resulting from the continuous process of switching (49.85 Hz to 50.15 Hz). The Tasmanian frequency band for no contingency event or load event aligns with that of NEM standards (49.85 Hz to 50.15 Hz).

Load event defines the maximum size of load that is subject to regular switching. The load event size that can be acceptably switched depends upon the capacity of generation in service. In the NEM standards there is no separate frequency band for load events. However due to the nature of the Tasmanian system where significant load switching in the order of 10% of the system demand is possible, a separate band for load event has been defined (49.0 Hz to 51.0 Hz). This event also includes those events where Basslink is taken in and out of service or power flows are being reversed on the link.

"Generation event" defines frequency excursions upon loss of the largest generating unit (47.5 Hz to 51.0 Hz). In the 2003 determination the RNPP narrowed the band for generation event by increasing the lower limit from 47.0 Hz to 47.5 Hz so that gas and wind generation technologies could be accommodated in the system. The NEM standards have a single band for generation or load event (49.5 Hz – 50.5 Hz) that is narrower than the Tasmanian standards.

"Network event" defines the largest load or generation loss resulting from the loss of a network element(s) due to a credible contingency (47.5 Hz to 53.0 Hz). To allow other generation technologies to be connected to the system and to support the management of credible contingency events, the 2003 determination increased the lower limit from 47.0 Hz to 47.5 Hz. The NEM standards (49 Hz to 51 Hz) are tighter than the Tasmanian standards.

"Separation event" means a credible contingency event in relation to a transmission element that forms an electrical island (46.0 Hz to 55.0 Hz). This band was introduced to the Tasmanian standards in the 2004 determination with the introduction of standards for electrical islands within the Tasmanian power system. The frequency band for the separation event specifies the frequency tolerances of the main system if an electrical island is formed. The NEM standards for separation event (49 Hz to 51 Hz) are narrower than the Tasmanian standards.

"Multiple contingency event" defines the largest frequency excursion where system equipment should, if possible, remain in service (46.0 Hz to 55.0 Hz). In the 2003 determination, the lower limit was increased from 44.8 Hz to 46 Hz as gas turbines and other thermal generation technologies and wind generators can only operate safely down to a frequency of around 46 Hz, and must be disconnected from the system if the frequency falls below this figure. The NER Glossary refers to this as the extreme frequency excursion tolerance limits. The NEM standards for multiple contingency event (47 Hz to 52 Hz) are narrower than the Tasmanian standards.

Frequency Band	Tasmanian Standard	NEM Standard	Comment
No contingency event or load event	49.85 to 50.15 Hz	49.85 to 50.15 Hz	No Issue – the requirements are the same.
Load event	49.0 to 51.0 Hz	49.5 to 50.5 Hz	NEM standard has single

Generation event	47.5 to 51.0 Hz		band for load and generation events
Network event	47.5 to 53.0 Hz	49.0 to 51.0 Hz	
Separation Event	46.0 to 55.0 Hz	49.0 to 51.0 Hz	
Multiple Contingency event	46.0 to 55.0 Hz	47.0 to 52.0 Hz	

Table 4 – Operating frequency Band Comparison – Tasmania / NEM

3.2 Characteristics of the Tasmania Power System

3.2.1 Contingency/Demand Ratio

Tasmania has wider frequency standards than the NEM because it is a smaller, isolated power system with slower response times due to its predominately hydro generators. A system incident that cause significant frequency variation has a proportionately larger effect on the Tasmanian power system than a similar incident in the larger interconnected NEM. Additionally, the relative proportion of wind generation in the Tasmania Power System does not help the situation, as the wind generators currently installed do not contribute any inertia to the power system.

In Tasmania the largest generator is approximately 16% of the minimum demand and the largest load is approximately 21.5% of the minimum demand. In the interconnected NEM the largest generator is approximately 5% of the minimum power system demand; for a load to be of the same proportion it would have to be in the order of 2700MW.

A major factor considered by the RNPP when setting the frequency standard for Tasmanian was the relation between the size of the largest generator or load and the total demand in the power system.

3.2.2 Interconnector Characteristics

With the mainland power system and the Tasmanian system connected by a DC interconnector, it is possible to facilitate frequency differences between the networks at each end of the link. There is no technical necessity to have the same frequency standards in Tasmania as in the NEM.

In their submission to the RNPP 2003 consultation NEMMCO advised that other than the lack of a frequency standard for an island event, NEMMCO saw no difficulty operating to the frequency operating standards that were due to come into effect on 1 August 2004. From a power system security perspective, NEMMCO foresaw no difficulty with frequency levels being different in Tasmania compared with the mainland.

3.3 Frequency Control Ancillary Services:

Frequency variations are remedied by ancillary services known as Frequency Control Ancillary Services (FCAS).

FCAS falls into two categories,

3.3.1 Regulation FCAS

The regulation frequency control services are provided by generators on Automatic Generation Control (AGC). The AGC system allows NEMMCO to continually monitor the system frequency and to send control signals out to generators providing regulation in such a manner that maintains the frequency within the normal operating band of 49.85 Hz to 50.15 Hz.

Prior to NEM entry Hydro Tasmania dispatched regulation FCAS using their AGC. Following NEM entry, control of regulation dispatch was transferred to NEMMCO's AGC.

NEMMCO initially had difficulty maintaining the normal operating frequency band within the frequency operating standards. NEMMCO subsequently increased the volume of regulation from 30MW to 50MW and reduced aggregate dispatch error from 25MW to 5MW which has resulted in significantly better performance and maintenance of frequency within the normal operating frequency band.

3.3.2 Contingency

Under the NEM frequency standards NEMMCO must ensure that, following a single contingency event, the frequency deviation remains within the single contingency band and is returned to the normal operating band within five minutes. Contingency services are provided by technologies that can locally detect the frequency deviation and respond in a manner that corrects the frequency. In Tasmanian this is achieved primarily through:

- Generator Governor Response: where the generator governor reacts to the frequency deviation by opening or closing the guide vanes or spears and altering the MW output of the set accordingly; and
- Load shedding: where a load can be quickly disconnected from the electrical system. Automatic Under Frequency Load Shedding, can act to correct a low frequency only.

3.3.3 FCAS Issues

The requirements specify eight exclusive MW amounts of FCAS that must be enabled by NEMMCO in order to meet the NEM frequency standards.

Table 5 identifies the eight (8) FCAS services.

Regulation	*Regulation Raise* *Regulation Lower*
Contingency	*Fast Raise and Fast Lower* (Six second response to arrest the immediate frequency deviation) *Slow Raise and Slow Lower* (Sixty second response to keep the frequency within the single contingency band) *Delayed Raise and Delayed Lower* (Five minute response to return the frequency to the Normal Operating Band)

Table 5 – FCAS Service Summary

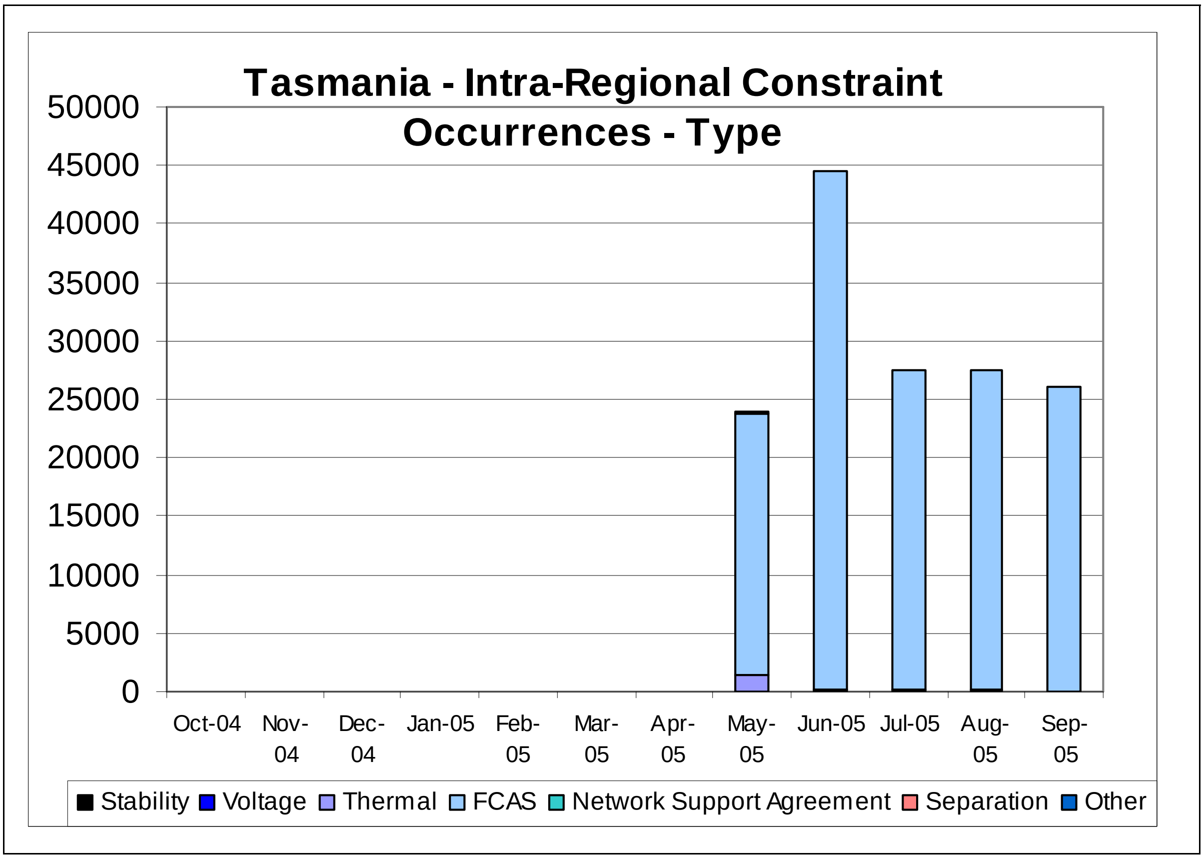
Hydro generators do not react to sudden changes in frequency as fast as thermal units. To change the speed of a hydro generator the water column must accelerate or decelerate and generally there is a time delay in this occurring. With a power system that has predominately hydro generators, such as Tasmanian, the provision of fast raise and fast lower services is an issue.

If Tasmania were to apply similar narrower frequency bands for the contingency services as in the NEM, Tasmanian customers would have to pay significantly higher costs for ancillary services with no tangible benefits to them.

An indication of the limited availability of FCAS services is the number of times generator dispatch is constrained by binding FCAS constraints. The graphs in diagram 1 identify the experience since NEM entry for the Tasmanian Region and also for comparison the Victorian and Queensland Regions.

It can be seen that the binding FCAS constraints for the Tasmanian Region are a number of orders of magnitudes greater than those in the other jurisdictions. Put simply, the outcome is that the deficiency in FCAS services results in energy dispatch being constrained to enable the maintenance of power system security (FCAS) thus increasing the cost of energy in the Tasmanian Region.

Therefore to tighten the frequency standards in Tasmania any further would increase the constraint on energy dispatch and, unless an equivalent efficiency offset could be achieved, add additional costs to customers without any significant increase in benefit.



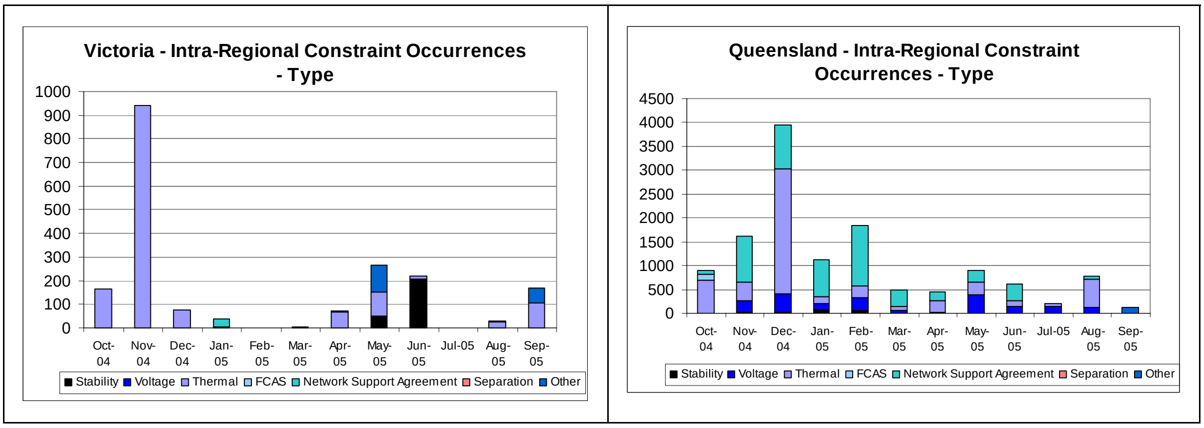


Diagram 1 – Binding Constraints

3.4 Past Performance

For the period from November 2004 until May 2005 power system frequency was within the normal operating band for 99.68% of the time. There were three occasions when system frequency for a load event moved outside the nominated band of 1 Hz. All other incidents were managed adequately by Frequency Control Ancillary Services (FCAS) reserves to maintain frequency within the nominated bands.

There were five occasions in May 2005 when system frequency was outside the normal band for 5 or more minutes. These excursions occurred during trial transfers of frequency control between Hydro Tasmania and NEMMCO.

NEMMCO's monthly reports on "Frequency & Time Deviation Monitoring in the NEM" for June, July, August and September 2005 note 54 occurrences of a load or generation event where the frequency did not return to the "no contingency event or load event" band within 300 seconds as required by the standard. It is understood that these occurrences resulted from inappropriate turbine governor control settings, and that discussions between Hydro Tasmanian and NEMMCO have resolved the problem. These occurrences have since reduced in number with only 24 such violations reported for the four-month period from October 2005 to January 2006.

3.5 Basslink

Basslink as a DC interconnector does not provide a synchronous link between Tasmanian and Victoria and consequently Tasmania will not be linked to the NEM in the same manner as other jurisdictions. Basslink does have a frequency controller which enables the interconnector to emulate a synchronous link which will enable the interconnector to transfer FCAS between Tasmanian and the rest of the NEM.

However, when Basslink is operating at its limits the provision of FCAS is constrained and the provision of the service must be sourced from within the Tasmanian region. This is also the case when Basslink transitions from import to export or export to import at which time Basslink operation is blocked. Diagram 2 provides indication of when FCAS limitations occur.

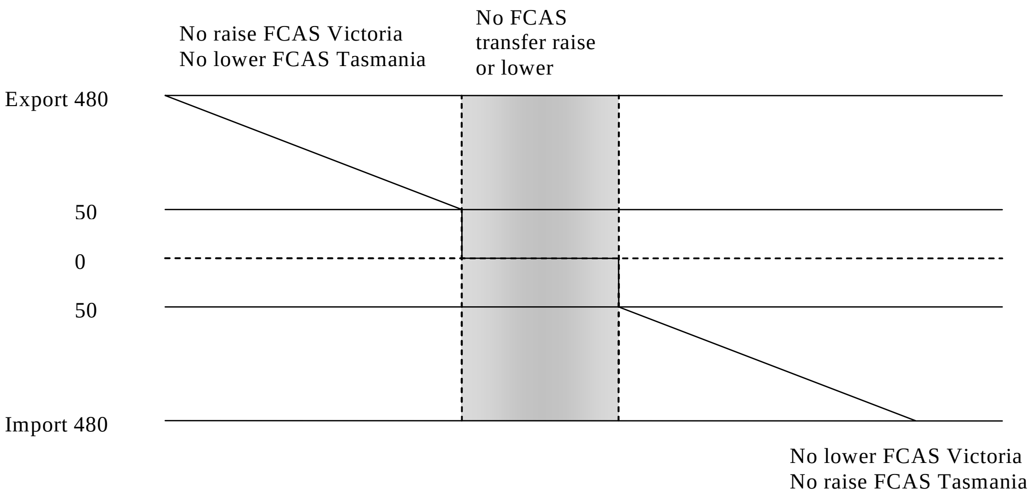


Diagram 2 – Basslink FCAS Transfer Limitations

The implications for the Operating Frequency Standards is that during periods when Basslink is capable of transferring FCAS, limitations with provision of the service may be overcome but there are significant periods when Basslink is not able to assist and consequently the provision of FCAS capability is limited to that which can be provided by Tasmanian participants.

3.6 Potential Implications

The Tasmanian frequency standards are not as tight as those operating in the NEM. Setting more stringent standards in Tasmania would have three main consequences:

- The cost of constructing new thermal and gas turbine generating plant in Tasmania would be reduced compared to the costs of constructing plant to meet the current minimum frequency of 46 Hz.
- The cost of ancillary services to meet the tighter service would be increased.
- Depending on other factors (such as the level of available generation reserve) under frequency load shedding may occur more often, leading to an increase in supply interruptions and associated costs being incurred by customers.

The additional cost of thermal plant is likely to make Tasmania a less attractive investment destination and a wider range for frequency regulation is likely to have an adverse impact on the steady state operation and life cycle of these generator units. Actions taken to relieve the cyclic stress due to poor frequency regulation significantly reduce a thermal generator's ability to bid into the FCAS market.

4.0 Summary

The Frequency Operating Standards in Tasmania are less onerous than the NEM standards. This is primarily because of the relatively small size of the power system compared to the size of the largest credible contingency combined with the type of generators connected (predominantly hydro), transmission characteristics and load response. The very much larger Mainland system is more “solid” electrically, has a higher system inertia and is relatively large compared to the largest credible contingency. Setting tighter frequency standards in Tasmania would require the provision of additional frequency control ancillary services at significant additional cost to Tasmanian customers. While these differences could be overcome, the costs of so doing would be high, far outweighing the benefits. Considering Tasmania is connected by a DC interconnector, it is appropriate that Tasmania operate as a separate Region with different frequency standards.

ATTACHMENT 1

SUMMARY OF TASMANIAN STANDARDS (2005)

The following table applies to any part of the Tasmanian power system, other than an island:

CONDITION	CONTAINMENT	STABILISATION	RECOVERY
accumulated time error	15 seconds		
no contingency event or load event	49.75 to 50.25 Hz, 49.85 to 50.15 Hz 99% of the time	49.85 to 50.15 Hz within 5 minutes	
load event	49.0 to 51.0 Hz	49.85 to 50.15 Hz within 10 minutes	
generation event	47.5 to 51.0 Hz	49.85 to 50.15 Hz within 5 minutes	
network event	47.5 to 53.0 Hz	49.0 to 51.0 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
separation event	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
multiple contingency event	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

The following table applies to an island within the Tasmanian power system, with effect from the date of OFGSS commissioning:

CONDITION	CONTAINMENT	STABILISATION AND RECOVERY	
no contingency event, or load event	49.0 to 51.0 Hz		
generation event or network event	47.5 to 53.0 Hz (Note 1)	49.0 to 51.0 Hz within 5 minutes	
load event	47.5 to 53.0 Hz (Note 1)	49.0 to 51.0 Hz within 10 minutes	
the separation event that formed the island	46 to 60 Hz	47.5 to 53.0 Hz within 2 minutes	49.0 to 51.0 Hz within 10 minutes
multiple contingency event including a further separation event	46 to 60 Hz	47.5 to 53.0 Hz within 2 minutes	49.0 to 51.0 Hz within 10 minutes

Note 1 Where it is not feasible to schedule sufficient frequency control ancillary service to limit frequency excursions to within this range, operation of the UFLSS or OFGSS is acceptable on the occurrence of a further contingency event.

ATTACHMENT 2

SUMMARY OF NEM STANDARDS

Frequency operating standards for the mainland regions as determined by the national Reliability Panel are given in the following tables:
Frequency Operating Standards for non-islanded system:

CONDITION	CONTAINMENT	STABILISATION	RECOVERY
No contingency or load event	49.75 – 50.25 Hz 49.85 to 50.15 Hz 99 % of time	49.85 to 50.15 Hz within 5 minutes	
Generation or load event	49.5 to 50.5 Hz	49.85 to 50.15 Hz within 5 minutes	
Network Event	49 to 51 Hz	49.5 – 50.5 Hz within 1 minute	49.85 – 50.15 Hz within 5 minutes
Separation Event	49 to 51 Hz	49.5 – 50.5 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
Multiple Contingency Event	47 to 52 Hz	49.5 to 50.5 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

Frequency Operating Standards for islanded system:

CONDITION	CONTAINMENT	STABILISATION	RECOVERY
No contingency or load event	49.5 to 50.5 Hz		
Generation, load or network event	49 to 51 Hz	49.85 to 50.15 Hz within 5 minutes	
Separation event that formed the island	49 to 51 Hz	49.0 – 51.0 Hz within 2 minutes	49.5 – 50.5 Hz within 10 minutes
Multiple Contingency Event	47 to 52 Hz	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes