NEMMCO

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Reliability and Frequency Operating Standards for Tasmania

NEMMCO's advice to the Reliability Panel

Prepared by: *System Operations and Planning*

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FINAL

1 BACKGROUND AND SUMMARY

Under clause 8.8.1(a)(2) of the National Electricity Rules (Rules), the AEMC Reliability Panel is required to determine the Tasmanian reliability and frequency standards on the advice of NEMMCO by 29 April 2006. The principles to be applied by the Panel in doing so are set out in the Rules clause 9.49.4, which is given in Attachment A.

The frequency standards determined by the Panel will apply from 30 May 2007 and the reliability standard will apply from the date that Basslink is commissioned (Rules clause 9.49.1).

This document has been prepared in response to the AEMC's request to NEMMCO to provide advice with regard to the Tasmanian reliability and frequency operating standards including:

> "a written report setting out NEMMCO's views as to the technical considerations surrounding the Panel's review of the current Tasmanian reliability and frequency standards under the Rules. As those standards currently differ from those of other National Electricity Market regions, specific advice on the technical merits of those differences would be highly useful"

In summary, NEMMCO's advice is that the frequency operating standards for Tasmania as currently being determined by the Tasmanian Reliability and Network Planning Panel (RNPP) be merged with the frequency operating standards for the mainland regions.

Given that NEMMCO has not yet had operational experience with Basslink in commercial service, the main changes in the frequency standard recommended at this time are changes arising from experience to date, namely:

- accommodate Basslink's starting and stopping actions as being similar to load events;
- allow slower frequency restoration in Tasmania while Basslink is not in operation by increasing the recovery time requirement to 10 minutes; and
- treat credible contingency events on connecting lines dedicated to single generating units as generation events.

With regard to reliability standards NEMMCO's advice is that the NEM standard of 0.002% un-served energy (USE) per annum, accounting for insufficient generation or bulk transmission capacity, should apply to Tasmania. The minimum reserve level for Tasmania should continue to be set at the size of the largest generating unit in Tasmania.

2 CURRENT TASMANIAN FREQUENCY OPERATING STANDARDS

The RNPP is currently consulting on the frequency operating standards for Tasmania, and has issued a consultation paper in December 2005. The particular matters currently under review by the RNPP are:

(a) frequency standards to apply to blocking and unblocking operations of Basslink;

(b) the recovery time for network events; and

(c) alignment with the National Electricity Market standards.

NEMMCO considers that the matter of Basslink blocking and unblocking needs to be considered. The manufacturer of the Basslink equipment uses the terms "blocking" to mean reducing flow to zero and switching off and "unblocking" to mean switching on and increasing

the flow rapidly through the no-go zone to its minimum operating level, as part of the process of starting, stopping or reversing the power flow on the link. NEMMCO understands that the actions of blocking and unblocking will cause step changes in power flow of about 50 MW. With steps of this size the Tasmanian power system frequency cannot be maintained within the normal operating frequency band as required by the frequency operating standards, and this blocking and unblocking operation should therefore be treated similar to a load change. In NEMMCO's submission to the RNPP consultation, it was mentioned that the derogation in clause 9.46.1 of the Rules would also lead to this outcome.

The current frequency operating standards including the changes proposed by the RNPP are given in Attachment B (the change marks, except for two minor typographical errors in Part C, show the changes currently proposed by the RNPP).

NEMMCO does not support the incorporation of the definitions of terms defined in the Rules Glossary into the standard, because it expands the document without making it self contained and leaves the possibility that the terms would become inconsistent with the Rules. NEMMCO also does not consider it necessary to annotate the standards with references to facilities in the form of Note 1 in Part A.

3 NEMMCO'S EXPERIENCE OF TASMANIAN FREQUENCY OPERATING STANDARDS

3.1 Operational Experience

Tasmania joined the National Electricity Market on 29 May 2005, and NEMMCO has had responsibility for Tasmanian frequency control since that time. NEMMCO has now had some seven months of experience with operating the Tasmanian power system without Basslink. At the present time (January 2006), Basslink is undergoing testing, but has not yet been commissioned. Therefore, NEMMCO's experience to date has been almost entirely with Tasmania as a separate power system.

The frequency operating standards to be determined by the Panel will apply from 30 May 2007, and will therefore need to be primarily for the situation where Basslink is in full commercial operation. However, NEMMCO has had insufficient operational experience of the Tasmanian power system with Basslink operating to foresee any difficulties with the Tasmanian frequency operating standards when Basslink is in commercial service, except for the matter of Basslink blocking and unblocking as mentioned above. NEMMCO proposes to report to the Reliability Panel again after 6 months of commercial service of Basslink.

With regard to the three components in the frequency standards of: containment; stabilisation; and recovery, the following points are relevant.

3.1.1 Containment of Frequency Deviations

There have not been any significant performance issues regarding the containment of frequency deviations within the relevant containment limits. However, there is a concern that at times there may not be sufficient fast frequency control ancillary service available within Tasmania to deal with network events, for two main reasons:

(a) Many of the large hydro-electric power stations in Tasmania have long penstocks and the delays associated with moving or stopping the water column causes their governor response to initially move in the opposite direction to what is required, usually for about 2 seconds. This makes it difficult for these units to provide fast frequency control ancillary services, compared with the thermal generating units that dominate this market on the mainland.

(b) Fast lower frequency control ancillary services are used for containment of frequency for both load events (where the standard limits frequency rises to 51 Hz) and network events (where the standard limits frequency rises to 53 Hz). The application of different frequency limits in the standard has lead to an inconsistency in ancillary service design which requires more service for the 53 Hz deviation than is needed, and in Tasmania the ancillary services requirement can exceed the amount of service actually available.

NEMMCO is currently addressing the shortage of fast lower frequency control ancillary service by discounting the requirement for network events by arrangement with Hydro Tasmania and Transend. Power system security is maintained by taking into account the additional governor response provided for a 3 Hz deviation compared with the 1 Hz deviation on which the service definition is based. The issue arises in principle on the mainland but the two limit frequencies in the mainland's standard are closer (50.5 and 51 Hz), and network events are rarely limiting. In addition on the mainland there is no shortage of supply of fast lower services.

Any consideration of changing the frequency operating standards for Tasmania should to take this issue into account by more closely aligning the frequency limits for load events and network events subject to economic considerations.

3.1.2 Stabilisation of Frequency Deviations

There are several situations in Tasmania where a generating unit is connected into the power system by a dedicated transmission line. Under the current standards, the frequency control ancillary service requirements are different depending on whether the generating unit trips due to a failure within the power station or due to a fault on the transmission line. In the latter case, frequency is required to stabilise above 49 Hz within 60 seconds, and this requires additional frequency control ancillary service.

NEMMCO's view is that in such cases the frequency standards, and therefore the frequency control ancillary service requirements, should be the same regardless of which side of the connection point a fault occurs and that additional frequency control ancillary service just in case the fault is on the transmission line is an unnecessary cost. NEMMCO therefore recommends that the standard be amended to treat loss of the connecting line the same as loss of the generating unit itself. Loss of multiple generating units due to a transmission fault should remain a network event.

To resolve this issue, NEMMCO recommends that the definition of "generation event" be amended by replacing the words "in relation to a single *generating unit*" with "in respect of either a single *generating unit* or a *transmission element* solely providing *connection* to a single *generating unit*".

3.1.3 Recovery to the Normal Operating Frequency Band

There have been many occasions when the frequency has not recovered to within the normal operating frequency band within the 5 minutes specified in the frequency operating standards, and this continues to be the main difficulty with frequency control in Tasmania. NEMMCO's investigations to date indicate that the main contributing factors are:

(a) the relatively large size of the largest loads and generating units as a proportion of Tasmanian demand; and

(b) the inability of delayed frequency control ancillary services to assist with recovery unless the frequency exceeds the relevant threshold.

NEMMCO has been able to improve performance by dispatching more regulating frequency control ancillary service when it has advance notice of major load changes, but, as Comalco has pointed out in its submission to the RNPP consultation, the need to wait until additional service is dispatched is adversely affecting its business.

NEMMCO supports the proposal that Comalco put to the RNPP that the recovery time in the frequency operating standards be extended to 10 minutes to allow time for dispatch of more regulating frequency control ancillary service if required. NEMMCO expects that recovery performance will be improved with Basslink in operation, and therefore recommends that the extension of time only apply while Basslink is not transferring power. When Basslink is transferring power but its response is limited, NEMMCO may need to revert to its existing procedure. As the same difficulty arises for recovery from generation events and network events, and for operational consistency, NEMMCO recommends that the change apply to these events as well.

NEMMCO does not expect any increase in frequency control ancillary service costs as a result of this change, and therefore there would be a net economic benefit (to customers).

3.2 Connection of New Generation

NEMMCO has had some experience applying the Tasmania frequency operating standards when assessing applications for connection of generating units to the Tasmanian grid. The National Electricity Rules require new generating units to comply with the technical requirements set out in clause S5.2.5.3, which, in part, reads as follows:

> "(a) Each *generating unit* must be capable of continuous uninterrupted operation during the occurrence of:
>
> (1) *Power system frequency* within the *frequency operating standards* limits and bands for periods not longer than the corresponding times specified in the *frequency operating standards* for the relevant limit or band."

Given the existing frequency operating standards, this clause requires Tasmanian generating units to be able to operate continuously during disturbances where the frequency lies within any of the following ranges for the specified time:

(a) 49 to 51 Hz indefinitely;

(b) 47.5 to 49 Hz for 8 minutes;

(c) 51 to 53 Hz for 8 minutes;

(d) 46 to 47.5 Hz for 2 minutes; and

(e) 53 to 60 Hz for 2 minutes.

These are the most onerous of the conditions specified in the frequency operating standards, applying to separation of the Tasmanian power system into islands.

Compliance with this Rules requirement, to be capable of uninterrupted operation at these frequencies for these periods of time, is a condition of connection, and, as it is not expressed in terms of minimum and automatic access standards like most other technical requirements, is considered mandatory. In particular, the extreme limits of 46 Hz and 60 Hz may be sufficiently onerous as to potentially present a barrier to entry of new generating plant.

Alinta Limited raised this issue in its submission to the RNPP consultation, with specific reference to the 46 Hz requirement. NEMMCO's experience of establishing performance standards for existing plant under the transitional arrangements in clause 4.14 of the Rules is that gas turbine plant is commonly designed for operation down to 47.5 Hz under IEC

standards, and there is considerable uncertainty about performance at frequencies below this level.

In NEMMCO's view, the requirement to operate at up to 60 Hz for 2 minutes may be more onerous, and should be reviewed and if possible relaxed. NEMMCO understands that the RNPP determination that set the limit of 60 Hz was based on simulations of disturbances in which the Tasmanian power system would separate into islands, but may not have considered the impact on connection of new plant. Subsequent to that determination, Transend has implemented an over-frequency generation tripping scheme.

NEMMCO intends to review and coordinate over-frequency tripping of generation across the National Electricity Market, using its limited powers under clause S5.2.5.8(a)(2) of the Rules. NEMMCO suggests that, as part of that review, it investigate whether, to what extent and at what likely cost, it would be practical to reduce the 60 Hz frequency limit. NEMMCO proposes to report to the Reliability Panel on this matter within the same time-frame as its report after 6 months of commercial service of Basslink mentioned in section 3.1 above.

3.3 Under-Frequency Load Shedding

Rules clause 4.3.5 requires that under-frequency load shedding on the mainland operate within the frequency range of 49 to 47 Hz. Rules derogation 9.46.3 changes the lower limit for Tasmania to the lower limit of the extreme frequency excursion limits applying in Tasmania (currently 46 Hz), but leaves the upper limit at 49 Hz even though credible contingency events could cause the frequency to fall below 49 Hz. The under-frequency load shedding scheme in Tasmania actually uses 47.5 Hz as the upper limit for load shedding (although with some rate of change of frequency relays initiated above 47.5 Hz).

NEMMCO's view is that the frequency ranges for under-frequency load shedding should be co-ordinated with the frequency operating standards. In principle, under-frequency load shedding should use settings between the lowest permissible frequency for a credible contingency event and the lowest permissible frequency for a non-credible contingency event. By this principle, under-frequency load shedding (other than as a frequency control ancillary service) should assist in the recovery from non-credible contingency events, but should not be required for any credible contingency event. Note that the existing mainland frequency operating standards allow a wider range with Jurisdictional System Security Coordinator agreement but this does not affect under-frequency load shedding arrangements.

NEMMCO is currently reviewing the under frequency load shedding arrangements for each mainland region, as requested by the MCE, particularly to review equity and technical coordination of load shedding across the NEM. NEMMCO will also consider Tasmanian load shedding in this regard at a later stage.

The under-frequency load shedding scheme in Tasmania was reviewed by Transend for post-Basslink operation. As NEMMCO has responsibility under the Rules for under-frequency load shedding settings, NEMMCO reviewed the Transend report and recommended some improvements. Transend has agreed to divide the largest load block into two to reduce the risk of over-shedding and to investigate more severe disturbances to ensure that the load shedding is adequate to protect the Tasmanian power system for simultaneous loss of Basslink and Tasmanian generation.

4 COMPARISON WITH MAINLAND FREQUENCY OPERATING STANDARDS

The key differences between the Tasmanian and mainland frequency operating standards are summarised as follows:

Disturbance condition	Tasmanian standard	Mainland standard
load event	49 to 51 Hz	49.5 to 50.5 Hz
generation event	47.5 to 51 Hz	49.5 to 50.5 Hz
network event	47.5 to 53 Hz	49 to 51 Hz
extreme frequency excursion limits	46 to 55 Hz	47 to 53 Hz
normal operating frequency band after separation	49 to 51 Hz	49.5 to 50.5 Hz
load, generation or network event after separation	47.5 to 53 Hz	49 to 51 Hz
extreme frequency excursion tolerance limits after separation	46 to 60 Hz	47 to 53 Hz

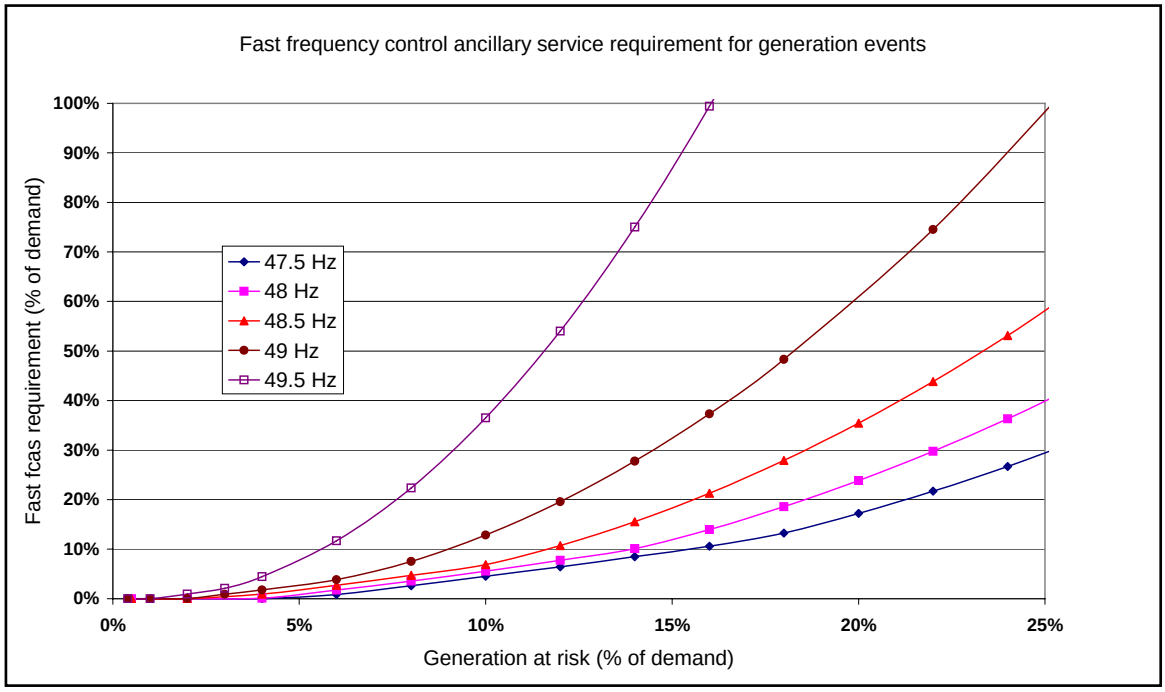
As required by clause 9.49.4 of the Rules (see Attachment A), any move to change the Tasmanian frequency operating standards to align with the mainland standards would need to consider the costs and benefits of any change. The most obvious costs and benefits are:

(a) increased frequency control ancillary service costs because more service would need to be dispatched to achieve tighter standards; and

(b) lower capital costs for connection of new generating units because plant needs to be more conservatively designed to operate over wider frequency ranges.

NEMMCO has no information regarding the impact of frequency standards on the capital cost of new plant, but can advise on how the quantities of the six contingency services would increase as frequency bands were tightened.

The following graph shows how the requirement for fast raise frequency control ancillary service, as a function of Tasmanian demand, without Basslink, would change with the frequency limit for generation events (assuming here an average level of inertia). Note that the very high requirements are due to the fact that relatively large generation losses, which cause the frequency to fall very rapidly, need to be arrested within the 6 second period of the fast frequency control ancillary service.

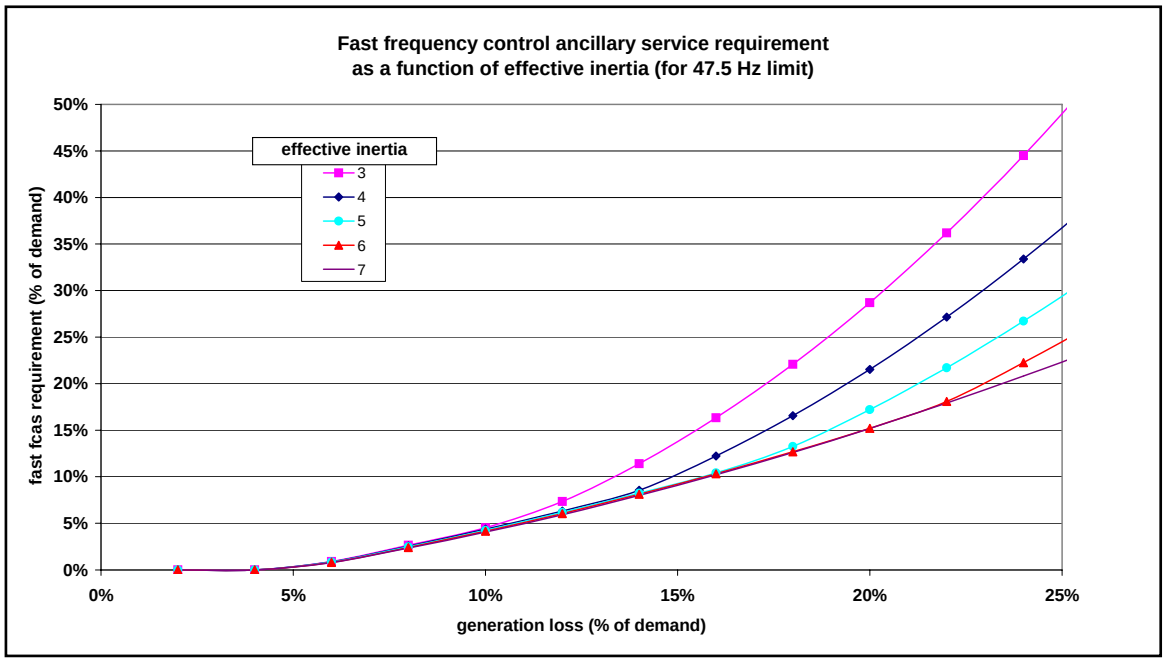


The graph also correctly describes the corresponding situation for the fast lower requirements for load events if the frequency deviation is converted to the same level above 50 Hz (ie 49 Hz becomes 51 Hz). The part of the graph where the requirement exceeds the amount of power at risk also represents the requirement for network events.

This graph shows that at a low Tasmanian demand of 1000 MW, to keep the frequency above the mainland limit of 49.5 Hz for loss of the largest generating unit would require about 900 MW of fast frequency control ancillary service. Particularly considering that many Tasmanian hydro-electric generating units are counter-productive in the first two seconds (as described in section 3.1.1 above) and that Basslink may not be able to assist (eg if close to maximum transfer to Tasmania), it would be impossible to provide such a large amount of service.

With Basslink in service, account needs to be taken of the effective change in Tasmanian inertia relative to demand. For Basslink transfer to Victoria, relative inertia is increased and the frequency control ancillary service requirement is less than shown on the above graph. Conversely, for Basslink transfer to Tasmania, relative inertia is decreased and the frequency control ancillary service requirement is more. For example, the variation of fast frequency control ancillary service requirement with effective inertia is shown in the following graph for the current frequency limit of 47.5 Hz. Effective inertia is the ratio of inertia (in MWs) to Tasmanian demand (in MW).

For Basslink trips, account also needs to be taken of the System Protection Scheme. This can be closely approximated by treating the amount of Basslink flow less the System Protection Scheme action as the amount of generation (or load) at risk.



If all Tasmanian generating units satisfied the automatic access standard of clause S5.2.5.11 of the Rules and were capable of delivering the required 5% raise response immediately, then they could at most deliver fast frequency control ancillary service equal to 10% of rating. When operating as an isolated power system, using the above graph, a reasonable frequency standard would be that requiring frequency control ancillary service of 10% for a generation loss of 14.4%, ie 47.5 Hz, which is the current level. Therefore, any tighter standard relies on generating units being able to deliver more service than required by the automatic access standard. Any higher frequency level would require NEMMCO to impose constraints on dispatch that would prevent the largest generating units from operating at their maximum output at times of low demand. The resulting inefficiencies of water use would represent an additional cost to those mentioned above. Note also that:

(a) as indicated above, Basslink flow into Tasmania increases the amounts of frequency control ancillary service required and so makes tighter standards less practical;

(b) as wind generation plant has much lower inertia than conventional plant, large amounts of wind generation reduce the system inertia level and so increase the amount of frequency control ancillary service required; and

(c) although the largest generating unit in Tasmania is currently 144 MW, this could increase at any time, and the requirements for raise frequency control ancillary services would need to increase considerably (almost doubling for a 200 MW unit).

Basslink has a frequency controller that adjusts flow dynamically in order to balance the frequencies in Tasmania and Victoria. Its effect is to transfer frequency control ancillary services between Tasmania and the mainland when the Basslink flow is not constrained by its technical limits. Although it is expected that this facility will considerably improve frequency control performance much of the time, it cannot be relied upon at all in situations where Basslink is not in operation, where it trips, or where it is operating close to a limit. In principle, it also should not be relied upon where the economic dispatch of the relevant frequency control ancillary service corresponding prices on each end are the same. Accordingly, NEMMCO would not recommend frequency operating standards with different sets of frequencies depending on Basslink's operational status.

Based on the above analysis, NEMMCO's view is that it would be quite impractical to impose the mainland frequency operating standards on the Tasmanian power system within the foreseeable future, but there could be some scope for minor adjustments towards alignment

standards when the Tasmanian power system becomes large enough, subject to economic justification. Changes to the frequency limits for credible contingency events could then allow changes to the extreme frequency excursion tolerance limits to facilitate connection of new generation, provided there is enough frequency range for practical implementation of under-frequency load shedding (such schemes would need about 1.5 Hz) and over-frequency generation tripping (such schemes would need about 1.5 Hz).

The following table gives an indication of what might be practical within the next few years (changes in bold):

Disturbance condition	Present standard	Possible standard
load event	49 to 51 Hz	49 to 51 Hz
generation event	47.5 to 51 Hz	**48** to 51 Hz
network event	47.5 to 53 Hz	**48** to **52** Hz
extreme frequency excursion limits	46 to 55 Hz	**46.5** to **53.5** Hz
normal operating frequency band after separation	49 to 51 Hz	49 to 51 Hz
load, generation or network event after separation	47.5 to 53 Hz	**47** to 53 Hz
extreme frequency excursion tolerance limits after separation	46 to 60 Hz	**46.5** to **54** Hz

Note that the Rules derogation in clause 9.49.4(c) (see Attachment A below) is not entirely clear, but appears to be requiring that standards applying after a separation event be less onerous than the corresponding standard that applies in the absence of separation. Because it specifically refers to isolation of a region, the derogation may also mean that standards that apply while Basslink is out of service must be less onerous than those that apply while Basslink is in service, but the existing standards do not comply with this interpretation.

5 CONSOLIDATION OF FREQUENCY OPERATING STANDARDS

In accordance with the above assessment, NEMMCO does not recommend any changes to the frequency levels of the frequency operating standards for Tasmania at this time. However, NEMMCO does recommend that the standards for Tasmania be combined with the existing standards applying to the mainland, to establish a common document, and updated to reflect the change from Code to Rules.

NEMMCO's proposal is attached as Attachment C, which was created by taking the current mainland standards and making amendments to add the Tasmanian standards. When combining the documents it was necessary to resolve the three different definitions of an island. The resulting definition is consistent with current practice and deals with coincident separations in Victoria and Tasmania (parts in each region are separate islands).

The only recommended changes beyond what is necessary to combine the standards are:

(a) As described in section 3.1.2 above, the definition of generation event is amended to ensure that it includes single generating unit trips of a dedicated connecting transmission line.

(b) As described in section 3.1.3 above, the restoration times for Tasmania load events, generation events and network events have been changed to 10 minutes when power

is not flowing on Basslink. Note that it is possible for Basslink to be "in service" but with no power actually flowing.

(c) As described in section 3.1.4 above, the definition of load event has been amended to include blocking and unblocking of Basslink.

6 RELIABILITY STANDARDS

The reliability of the energy market is measured by comparing against the standard the amount of energy not supplied to customers as a result of insufficient generating or bulk transmission capacity.

The reliability standard of 0.002 per cent un-served energy (USE) was set by the Reliability Panel in 1998 for this purpose.

NEMMCO notes that the Tasmanian Reliability and Network Planning Panel (RNPP) also set the un-served energy standard "*not to be more than 0.002 per cent per annum*" and that this is for the failure of generating equipment only (excludes bulk transmission).

Based on previous experience with the calculation of minimum reserve levels to meet the NEM reliability standard, NEMMCO found that the amount of unserved energy arising from bulk transmission forced outages is extremely small and as a result there is little difference between the NEM and RNPP definitions.

Therefore NEMMCO recommends that the NEM standard of 0.002 per cent USE per annum (accounting for insufficient generation or bulk transmission capacity) should apply to Tasmania, effectively maintaining the current situation.

6.1 Minimum Reserve Levels for Tasmania

The 0.002 per cent USE reliability standard is a statistical risk of not meeting consumer demand over time. To meet this standard operationally, NEMMCO calculates the minimum level of generation capacity dispersed across regions to just meet the 0.002 per cent USE standard in all regions. The minimum generation capacity of a region is then expressed as a minimum reserve level tied to the 10 per cent probability of exceedence peak demand of that region.

NEMMCO's calculations of minimum reserve level take account of plant performance characteristics such as generation and transmission interconnector forced outage rates, transmission network constraints and the characteristics of demand including weather and regional diversity.

NEMMCO uses these minimum reserve levels in four time horizons, namely:

(i) in pre-dispatch to provide forecasts of reserve one day ahead;

(ii) in the short term projected assessment of system adequacy (ST PASA) to provide forecasts of reserve one week ahead;

(iii) in the medium term projected assessment of system adequacy (MT PASA) to provide forecasts of reserve up to two years ahead; and

(iv) in NEMMCO's annual Statement of Opportunities (SOO), which reports on supply adequacy over a 10 year time horizon.

Any regional reserve shortfalls (ie: available generation capacity insufficient to meet region 10 per cent probability of exceedence demand plus minimum reserve level) projected in the ST PASA and MT PASA signal the possibility of NEMMCO intervention through the reliability safety net.

NEMMCO notes that the RNPP has set a short and medium capacity reserve standard equal to the size of the most critical credible contingency event on the Tasmanian Power System. This is currently set at 144 MW, the size of the largest generation unit in Tasmania.

It should be noted that the minimum reserve levels for the mainland regions are not referenced to credible contingency events (critical contingency sizes are more relevant to power system security issues). However, given that almost all Tasmanian generation is hydro-electric and therefore able to start rapidly (compared with predominantly thermal plant on the mainland), NEMMCO expects that a minimum reserve level equal to the size of the largest generating unit in Tasmania will deliver 0.002 per cent USE (or better).

NEMMCO has commenced a review of the minimum reserve level for all regions. The need for this review has been triggered major power system changes resulting from the commissioning of Basslink and the connection of Kogan Creek power station in 2007.

7 RECOMMENDATIONS

7.1 Frequency Operating Standards

NEMMCO recommends that the frequency operating standards for Tasmania be merged with the frequency operating standards for the mainland regions, and updated to reflect the change from National Electricity Code to National Electricity Rules.

Given that NEMMCO has not yet had operational experience with Basslink in commercial service, the only other changes recommended at this time are changes arising from experience to date, namely:

(a) accommodate Basslink blocking and unblocking similarly to load events;

(b) allow slower restoration in Tasmania while Basslink is not operating to reduce adverse impact on major customers; and

(c) treat credible contingency events that directly result in loss of single generating units more consistently as generation events, reducing the requirement for slow frequency control ancillary service.

7.2 Reliability Standard

NEMMCO recommends that the NEM standard of 0.002 USE per annum (accounting for insufficient generation or bulk transmission capacity) should apply to Tasmania.

The minimum reserve level for Tasmania should continue to be set at the size of the largest generating unit in Tasmania and that this be applied by NEMMCO in the pre-dispatch, ST PASA, MT PASA and SOO timeframes.

ATTACHMENT A

PRINCIPLES TO BE APPLIED BY RELIABILITY PANEL

The principles to be applied by the Panel are set out in clause 9.49.4 of the Rules, as follows:

9.49.4 Principles to be applied by Reliability Panel

In determining and amending *power system security and reliability standards* the *Reliability Panel* must ensure that, in so far as they apply in respect of Tasmania, those standards reflect the following principles:

(a) in so far as they relate to *frequency*, such standards must be made having regard to the following:

(1) any existing standards in relation to those matters;

(2) the costs and benefits of any change proposed to those existing standards; and

(3) the size and characteristics of the separate systems that make up the *power system*;

(b) where the *network* or *networks* located in a particular area or *region* in Tasmania is or are only *connected* to other areas or *regions* by means of an asynchronous link, the *power system security and reliability standards*, in so far as they relate to *frequency*, may incorporate different standards for the first area or *region* to those applying elsewhere in the *power system*; and

(c) the *power system security and reliability standards*, in so far as they relate to *frequency*, must allow less stringent standards for the *frequency* of a *network* or *networks* located in a particular area or *region* in Tasmania when that area or *region* is isolated from the remainder of the *power system*.

ATTACHMENT B

CURRENT TASMANIAN FREQUENCY OPERATING STANDARDS

The changes (except for some minor typographical corrections) marked in these standards are the changes currently proposed by the RNPP. NEMMCO understands that the Over-Frequency Generation Shedding Scheme (OFGSS) mentioned below has now been commissioned.

PART A SUMMARY OF THE STANDARDS

The *frequency operating standards* set out in Part B are summarised in the following tables for convenience. To the extent of any inconsistency between these tables and Part B below, Part B prevails.

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 ~~5~~ 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, *load event* or *network event*	47.5 to 53.0 Hz (Note 1)	49.0 to 51.0 Hz within 5 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.

PART B THE FREQUENCY OPERATING STANDARDS

~~From the date Basslink is commissioned, for~~ For the purposes of the *Rules* ~~*Code*~~, the *frequency operating standards*, forming part of the *power system security and reliability standards*, that apply in Tasmania are:

a) except in an *island*, the *accumulated time error* should not exceed 15 seconds;

b) except as a result of a *contingency* or a *load event*, *system frequency* should not exceed the applicable *normal operating frequency excursion band* and should not exceed the applicable *normal operating frequency band* for more than five minutes on any occasion and for not more than 1% of the time over any 30 day period;

c) as a result of a *generation event* ~~or a *load event*~~, *system frequency* should not exceed the applicable *generation change band* ~~or *load change band* (respectively)~~ and should not exceed the applicable *normal operating frequency band* for more than five minutes;

d) as a result of a *load event*, *system frequency* should not exceed the *load change band* and should not exceed the applicable *normal operating frequency band* for more than 10 minutes;

e) as a result of any *network event*, *system frequency* should not exceed the applicable *operational frequency tolerance band* and should not exceed the applicable *load change band* for more than one minute or the applicable *normal operating frequency band* for more than five minutes.

f) as a result of any *separation event*, *system frequency* should not exceed the applicable *island separation band* and should not exceed the applicable *load change band* for more than two minutes or the applicable *normal operating frequency band* for more than 10 minutes.

g) as a result of any *multiple contingency event*, *system frequency* should not exceed the applicable *extreme frequency excursion tolerance limits* and should not exceed the applicable *load change band* for more than two minutes while there is no *contingency event* or the applicable *normal operating frequency band* for more than 10 minutes while there is no *contingency event*.

PART C APPLICATION OF CODE RULES TERMS

For the purposes of these *frequency operating standards* and the *Rules Code*, a term shown in Column 1 of the following table has the corresponding range shown in Column 3 of the table for an *island* and has the corresponding range shown in Column 2 of the Table otherwise.

Column 1	**Column 2**	**Column 3**
Term	**Normal range (Hz)**	**Island range (Hz)**
normal operating frequency band	49.85 to 50.15	49.0 to 51.0
normal operating frequency excursion band	49.75 to 50.25	~~2~~49.0 to 51.0
extreme frequency excursion tolerance limits	46.0 to 55.0	46.0 to 60.0

PART D DEFINITIONS

Words and phrases shown in italics in this document have the meaning given to the in the following table:

Term	**Reference**	**Meaning**
accumulated time error		means, in respect of a measurement of *system frequency* that *NEMMCO* uses for controlling system frequency, the integral over time of the difference between 20 milliseconds and the inverse of that *system frequency*, starting from a time *published* by *NEMMCO*
Rule		means National Electricity Rules ~~Code~~
connection point	Glossary - NER	The agreed point of supply established between *Network Service Provider*(s) and another *Registered Participant*, *Non-Registered Customer* or franchise customer.
contingency event	Clause 4.2.3(a) – NER	A "*contingency event*" means an event affecting the *power system* which *NEMMCO* expects would be likely to involve the failure or removal from operational service of a *generating unit* or *transmission element.*
credible contingency event	Clause 4.2.3(b), Schedule 5.1 - NER	A "*credible contingency event*" means a *contingency event* the occurrence of which *NEMMCO* considers to be reasonably possible in the surrounding circumstances including the *technical envelope*. Without limitation, examples of *credible contingency events* are likely to include: 1. the unexpected automatic or manual *disconnection* of, or the unplanned reduction in capacity of, one operating *generating unit*; or 2. the unexpected *disconnection* of one major item of *transmission plant* (e.g. *transmission line*, *transformer* or *reactive plant*) other than as a result of a three phase electrical fault anywhere on the *power system*.

Term	Reference	Meaning
extreme frequency excursion tolerance limits	Glossary - NER	In relation to the *frequency* of the *power system*, means the limits so described and specified in the *power system security and reliability standards.*
generating unit	Glossary - NER	The actual generator of electricity and all the related equipment essential to its functioning as a single entity.
generation	Glossary - NER	The production of electrical power by converting another form of energy in a *generating unit*.
generation change band		means the frequency range of 47.5 to 53.0 Hz in respect of an *island* and the frequency range of 47.5 to 51.0 Hz otherwise.
generation event		means a *synchronisation* of a *generating unit* of more than 50 MW or a *credible contingency event* in relation to a single *generating unit*, not arising from a *network event*, a *separation event* or a part of a *multiple contingency event*.
island		means a part of the Tasmanian *power system* that includes *scheduled generation*, *networks* and *load* for which all of its alternating current network connections with other parts of the *power system* have been disconnected
island separation band		means the *extreme frequency excursion tolerance limits*
load	Glossary - NER	A *connection point* or defined set of *connection points* at which electrical power is delivered to a person or to another *network* or the amount of electrical power delivered at a defined instant at a *connection point*, or aggregated over a defined set of *connection points*
load change band		means the frequency range of 47.5 to 53.0 Hz in respect of an *island* and the frequency range of 49.0 to 51.0 Hz otherwise.
load event		means an either an identifiable increase or decrease of more than ~~50~~ 20 MW of customer load (whether at a *connection point* or otherwise), or a rapid change of flow by a *market network service provider* to or from 0 MW for the purpose of starting, stopping or reversing its power flow, not arising from a *network event*, a *generation event*, *a separation event* or a part of a *multiple contingency event*
market network service provider	Glossary - NER	A *Network Service Provider* who has classified any of its *network services* as a *market network service* in accordance with Chapter 2 and who is also registered by *NEMMCO* as a *Market Network Service Provider* under Chapter 2.
multiple contingency event		means either a *contingency event* other than a *credible contingency event*, a *sequence of credible contingency events* within a period of 5 minutes, or a further *separation event* in an *island*

Term	Reference	Meaning
national grid	Glossary - NER	The sum of all *connected transmission* and *distribution systems* within the *participating jurisdictions*
NEMMCO	Glossary - NER	National Electricity Market Management Company Limited A.C.N. 072 010 327.
network	Glossary - NER	The apparatus, equipment, plant and buildings used to convey, and control the conveyance of, electricity to customers (whether wholesale or retail) excluding any *connection assets*. In relation to a *Network Service Provider*, a *network* owned, operated or controlled by that *Network Service Provider*
network event		means a *credible contingency event* other that a *generation event*, a *separation event* or a part of a *multiple contingency event*
normal operating frequency band	Glossary - NER	In relation to the *frequency* of the *power system*, means the range 49.9Hz to 50.1Hz or such other range so specified in the *power system security and reliability standards*.
normal operating frequency excursion band	Glossary - NER	In relation to the *frequency* of the *power system*, means the range specified as being acceptable for infrequent and momentary excursions of *frequency* outside the *normal operating frequency band*, being the range of 49.75 Hz to 50.25 Hz or such other range so specified in the *power system security and reliability standards.*
operational frequency tolerance band	Glossary - NER	The range of *frequency* within which the *power system* is to be operated to cater for the occurrence of a *contingency event* as specified in the *power system security and reliability standards.*
power system	Glossary - NER	The electricity power system of the *national grid* including associated *generation* and *transmission* and *distribution networks* for the *supply* of electricity, operated as an integrated arrangement.
power system security and reliability standards	Glossary - NER	The standards governing *power system security* and *reliability* of the *power system* which are approved by the *Reliability Panel* on the advice of *NEMMCO*. They may include but are not limited to standards for the *frequency* of the *power system* in operation, *contingency capacity reserves* (including guidelines for assessing requirements and utilisation), *short term capacity reserves*, *medium term capacity reserves* and *system restart*.
publish	Glossary - NER	Make available to *Registered Participants* electronically.
separation event		means a *credible contingency event* in relation to a *transmission element* that forms an *island.*
synchronisation	Glossary - NER	The act of *synchronising* a *generating unit* or a *scheduled network service* to the *power system*.

Term	Reference	Meaning
system frequency		means the frequency of a part of the *power system*, including the frequency of an *island.*
technical envelope	NER Clause 4.2.5	means the technical boundary limits of the *power system* for achieving and maintaining a *secure operating state* of the *power system* for a given demand and *power system* scenario.
transmission element	Glossary - NER	A single identifiable major component of a *transmission system* involving: (a) an individual *transmission* circuit or a phase of that circuit; (b) a major item of *transmission plant* necessary for the functioning of a particular *transmission* circuit or *connection point* (such as a *transformer* or a circuit breaker).
transmission network	Glossary - NER	A *network* within any *participating jurisdiction* operating at nominal *voltages* of 220 kV and above plus: (a) any part of a *network* that operates at nominal *voltages* between 66 kV and 220 kV that operates in parallel to and provides support to the high voltage *transmission network*; (b) any part of a *network* that operates at nominal *voltages* between 66 kV and 220 kV that is not referred to in paragraph (a) but is deemed by the AER to be part of the *transmission network*.

ATTACHMENT C

PROPOSED CONSOLIDATED FREQUENCY OPERATING STANDARDS

PART A SUMMARY OF THE STANDARDS

The *frequency operating standards* set out in Part B below are summarised in the following tables for convenience. To the extent of any inconsistency between these tables and Part B below, Part B prevails.

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

Condition	Containment	Stabilisation	Recovery
accumulated time error	5 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	
generation event 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 to 50.5 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
separation event	49 to 51 Hz	49.5 to 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

The following table applies to any part of the Tasmania *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 to 51 Hz	49.85 to 50.15 Hz within 5 minutes or 10 minutes if no *interconnector* flow	
generation event	47.5 to 51 Hz	49.85 to 50.15 Hz within 5 minutes or 10 minutes if no *interconnector* flow	
network event	47.5 to 53 Hz	49 to 51 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes or 10 minutes if no *interconnector* flow
separation event	46 to 55 Hz	49 to 51 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
multiple contingency event	46 to 55 Hz	49 to 51 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

The following table applies to an *island* in a *mainland region*:

Condition	**Containment**	**Stabilisation and Recovery**	
no *contingency event, or load event*	49.5 to 50.5 Hz		
generation event, load event or *network event*	49 to 51 Hz	49.5 to 50.5 Hz within 5 minutes	
the *separation event* that formed the *island*	49 to 51 Hz or a wider band notified to *NEMMCO* by a relevant *Jurisdictional System Security Coordinator*	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes
multiple contingency event including a further *separation event*	47 to 52 Hz	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes

The following table applies to an *island* in Tasmania *region*:

Condition	**Containment**	**Stabilisation and Recovery**	
no *contingency event, or load event*	49 to 51 Hz		
generation event, load event or *network event*	47.5 to 53 Hz	49 to 51 Hz within 5 minutes or 10 minutes if no *interconnector* flow	
the *separation event* that formed the *island*	46 to 60 Hz	47.5 to 53 Hz within 2 minutes	49 to 51 Hz within 10 minutes
multiple contingency event including a further *separation event*	46 to 60 Hz	47.5 to 53 Hz within 2 minutes	49 to 51 Hz within 10 minutes

PART B THE FREQUENCY OPERATING STANDARDS

For the purposes of Chapters 4, 5 and 10 of the National Electricity ~~Code~~Rules, the *frequency operating standards*, forming part of the *power system security and reliability standards*, are:

(a) except in an *island*, the *accumulated time error* should not exceed 5 seconds in a *mainland region* or 15 seconds in the Tasmania *region*;

(b) except as a result of a *contingency event* or a *load event*, *system frequency* should not exceed the applicable *normal operating frequency excursion band* and should not exceed the applicable *normal operating frequency band* for more than five minutes on any occasion and not for more than 1% of the time over any 30 day period;

(c) as a result of ~~a *generation event* or~~ a *load event*, *system frequency* should not exceed the applicable ~~*generation and*~~ *load change band* and should not exceed the applicable *normal operating frequency band* for more than five minutes or ten minutes in Tasmania *region* while the Tasmania *interconnector* is not transferring power;

(d) as a result of a *generation event*, *system frequency* should not exceed the applicable *generation change band* and should not exceed the applicable *normal operating frequency band* for more than five minutes or ten minutes in Tasmania *region* while the Tasmania *interconnector* is not transferring power;

(~~d~~e) as a result of any *network event*, *system frequency* should not exceed the applicable *operational frequency tolerance band* and should not exceed the applicable ~~*generation and*~~ *load change band* for more than one minute or exceed the applicable *normal operating frequency band* for more than five minutes or ten minutes in Tasmania *region* while the Tasmania *interconnector* is not transferring power;

(~~e~~f) as a result of any *separation event*, *system frequency* should not exceed the applicable *island separation band* and should not exceed the applicable ~~*generation and*~~ *load change band* for more than two minutes or exceed the applicable *normal operating frequency band* for more than ten minutes; and

(~~f~~g) as a result of any *multiple contingency event*, *system frequency* should not exceed the *extreme frequency excursion tolerance limits* and should not exceed the applicable ~~*generation and*~~ *load change band* for more than two minutes while there is no *contingency event* or exceed the applicable *normal operating frequency band* for more than ten minutes while there is no *contingency event*.

PART C APPLICATION OF ~~CODE~~RULES TERMS

For the purposes of these *frequency operating standards* and Chapters 4, 5 and 10 of the National Electricity ~~Code~~Rules, a term shown in Column 1 of the following table has the corresponding range shown in: ~~Column 3 of the table for an *island* and has the corresponding range shown in Column 2 of the table otherwise.~~

(a) Column 2 for a *mainland region* but not an *island*;

(b) Column 3 for an *island* in one or more *mainland regions*;

(c) Column 4 for the Tasmania *region* but not an *island*; and

(d) Column 5 for an *island* in the Tasmania *region*.

Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**
	mainland	***mainland***	**Tasmania**	**Tasmania**
Term	**Normal range (Hz)**	**Island range (Hz)**	**Normal range (Hz)**	**Island range (Hz)**
normal operating frequency band	49.85 to 50.15	49.5 to 50.5	49.85 to 50.15	49.0 to 51.0
normal operating frequency excursion band	49.75 to 50.25	49.5 to 50.5	49.75 to 50.25	49.0 to 51.0
operational frequency tolerance band	49.0 to 51.0	49.0 to 51.0	47.5 to 53.0	47.5 to 53.0
extreme frequency excursion tolerance limits	47.0 to 52.0	47.0 to 52.0	46.0 to 55.0	46.0 to 60.0

PART D DEFINITIONS

Words and phrases shown in Italics in this document have the meaning given to them in the following table:

Term	Meaning
~~*abnormal frequency island*~~	~~means a part of the *power system* that includes *generation*, *networks* and *load* for which all of its alternating current *network* connections with other parts of the *power system* have been disconnected, provided that the part does not include more than half of the *generation* of each of two *regions* (determined by *available capacity* before disconnection).~~
accumulated time error	means, in respect of a measurement of *system frequency* that *NEMMCO* uses for controlling *system frequency*, the integral over time of the difference between 20 milliseconds and the inverse of that *system frequency*, starting from a time *published* by *NEMMCO*.
available capacity	has the meaning given to it in the National Electricity ~~Code~~Rules.
connection point	has the meaning given to it in the National Electricity Rules~~Code~~.
contingency event	has the meaning given to it in the National Electricity Rules~~Code~~.
credible contingency event	has the meaning given to it in the National Electricity Rules~~Code~~.
~~*electrical island*~~	~~means a part of the *power system* that includes *generation*, *networks* and *load*, for which all of its *network* connections with other parts of the *power system* have been disconnected, provided that the part does not include more than half of the *generation* of each of two *regions* (determined by *available capacity* before disconnection).~~
extreme frequency excursion tolerance limits	has the meaning given to it in the National Electricity ~~Code~~Rules.
frequency operating standards	has the meaning given to it in the National Electricity ~~Code~~Rules and are the standards set out in Part B of this document.
generating unit	has the meaning given to it in the National Electricity ~~Code~~Rules.
generation	has the meaning given to it in the National Electricity ~~Code~~Rules.
generation ~~*and load*~~ *change band*	means the frequency range of: (a) 49.5 to 50.5 Hz for a mainland *region* but not an *island*; (b) 49.0 to 51.0 Hz for an *island* in a *mainland region*; (c) 47.5 to 51.0 Hz for the Tasmania *region* but not an *island*; and (d) 47.5 to 53.0 Hz for an *island* in the Tasmania *region*.~~49.0 to 51.0 Hz in respect of an *island* and the frequency range of 49.5 to 50.5 Hz otherwise .~~
generation event	means a *synchronisation* of a *generating unit* of more than 50 MW or a *credible contingency event* in ~~relation to~~ respect of either a single *generating unit* or a *transmission element* dedicated to a single *generating unit*, not arising from a *network event*, a *separation event* or a part of a *multiple contingency event*.
interconnector	has the meaning given to it in the National Electricity Rules.

Term	Meaning
island	means a part of either the *mainland power system* or the Tasmania *power system* (but not a combination of parts of both) that includes *generation*, *networks* and *load* for which all of its alternating current *network* connections with other parts of the *power system* have been disconnected, provided that the part does not include more than half of the *generation* of each of two *regions* (determined by *available capacity* before disconnection).~~means either an *electrical island* or an *abnormal frequency island*.~~
island separation band	means: (a) in respect of a part of the *power system* that is not an *island*, the applicable *operational frequency tolerance band*; (b) in respect of an *island* that includes a part of the *power system* to which no notice under paragraph (c) applies, the applicable *operational frequency tolerance band*; and (c) otherwise in respect of a~~n~~ *mainland island*, the frequency band determined by the most restrictive of the high limits and low limits of frequency ranges outside the applicable *operational frequency tolerance band* notified by *Jurisdictional System Security Coordinators* to *NEMMCO* with adequate notice to apply to a nominated part of the *island* within their respective jurisdictions.
Jurisdictional System Security Coordinator	has the meaning given to it in the National Electricity ~~Code~~Rules.
load	has the meaning given to it in the National Electricity ~~Code~~Rules.
load block	means an amount of customer load of at least 50 MW for a *mainland region* or 20 MW for the Tasmania *region*.
load change band	means the frequency range of: (a) 49.5 to 50.5 Hz for a *mainland region* but not an *island*; (b) 49.0 to 51.0 Hz for an *island* in a *mainland region*; (c) 49.0 to 51.0 Hz for the Tasmania *region* but not an *island*; and (d) 47.5 to 53.0 Hz for an *island* in the Tasmania *region*.
load event	means: (a) an identifiable connection or disconnection of ~~more than 50 MW of customer load~~ a *load block* (whether at a *connection point* or otherwise); or (b) a rapid change of power flow of a high voltage direct current *interconnector* to or from 0 MW for the purpose of starting, stopping or reversing its power flow, not arising from a *network event*, a *generation event*, *a separation event* or a part of a *multiple contingency event*.
mainland	means, in respect of a *region* or *power system*, other than Tasmania.
multiple contingency event	means either a *contingency event* other than a *credible contingency event*, a sequence of *credible contingency events* within a period of 5 minutes, or a further *separation event* in an *island*.

Term	Meaning
NEMMCO	has the meaning given to it in the National Electricity ~~Code~~Rules.
network	has the meaning given to it in the National Electricity ~~Code~~Rules.
network event	means a *credible contingency event* other than a *generation event*, a *separation event* or a part of a *multiple contingency event.*
normal operating frequency band	has the meaning given to it in the National Electricity ~~Code~~Rules.
normal operating frequency excursion band	has the meaning given to it in the National Electricity ~~Code~~Rules.
operational frequency tolerance band	has the meaning given to it in the National Electricity ~~Code~~Rules.
power system	has the meaning given to it in the National Electricity ~~Code~~Rules.
power system security and reliability standards	has the meaning given to it in the National Electricity ~~Code~~Rules.
publish	has the meaning given to it in the National Electricity ~~Code~~Rules.
region	has the meaning given to it in the National Electricity ~~Code~~Rules.
separation event	means a *credible contingency event* in relation to a *transmission element* that forms an *island.*
synchronisation	has the meaning given to it in the National Electricity ~~Code~~Rules.
system frequency	means the frequency of a part of the *power system*, including the *frequency* of an *island*.
transmission element	has the meaning given to it in the National Electricity ~~Code~~Rules.