NEMMCO

National Electricity Market
Management Company Ltd

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Sydney

26 August, 2008

Mr Ian Woodward
AEMC Reliability Panel
Level 5 201 Elizabeth St
Sydney NSW 2000

Dear Ian

FINAL ADVICE ON TASMANIAN FREQUENCY OPERATING STANDARDS

Please find attached NEMMCO's final advice on possible changes to the Tasmanian Frequency Operating Standard as requested by the Reliability Panel.

NEMMCO has examined the technical implications of a change to the Tasmanian Frequency Operating Standard in order to accommodate the technical limitations of higher efficiency thermal generating plant .

NEMMCO's conclusion is that such a change is only possible if

(a) measures are put in place to limit the size of the largest generator event down to about 144 MW in conditions where Raise FCAS is in short supply;

(b) at least the first two higher efficiency thermal generating plants to be installed offer fast lower services; and

(c) suitable settings for over frequency tripping of all higher efficiency thermal generating plant can be agreed.

There may also be a requirement for higher efficiency thermal generating plant to be connected to the Basslink SPS to maintain the current levels of transfer capability from Tasmania to Victoria. However, even if these conditions are met, such a change in the frequency operating standard will still create a number of issues to be managed particularly when only one new generator is connected.

Please contact Mark Miller on 02 8884 5020 if wish to discuss this matter further.

Yours sincerely

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Advice to the Reliability Panel from NEMMCO regarding Proposed Changes to the Tasmanian Frequency Operating Standards

1. Introduction

It is proposed to install in the Tasmanian Region new higher efficiency thermal generating plant with a higher contingency size (typically 210MW) and a tighter frequency operating band (47 Hz to 52Hz).

In order to accommodate such higher efficiency thermal generating plant, NEMMCO has assumed that the necessary changes to the frequency operating standard for the Tasmanian Region for interconnected operation would be to:

(a) raise the lower boundary for the multiple contingency event containment band from 46.0 Hz to 47.0 Hz;

(b) lower the upper boundary for the network event containment band from 53.0 Hz to 52.0 Hz.

Because of change (a) the band for setting operation of the UFLS would be reduced to a width of 0.5 Hz. However, the minimum practical width for the UFLS band is about 1.0 Hz and a consequential change would, therefore, also be required as follows:

(c) raise the lower boundary for the network and generation event containment band from 47.5 Hz to 48.0 Hz.

There would also need to be corresponding changes for the separation event and island operation.

NEMMCO does not believe that there will be any requirement for changes to the normal frequency operating band or limits on time error.

2. Management of Under Frequency following a Credible Contingency Event

Management of under frequency is most demanding when Basslink is out of service or blocked as Basslink is not available to supply fast raise (R6) services from the mainland.

Hydroelectric plant has difficulty in providing fast response in the 6 second time frame and so provision of fast lower and raise services will always be an issue for systems such as Tasmania which have predominance of hydroelectric plant. The studies below have thus concentrated on the requirement for adequacy of R6 services as this is likely to be the limiting factor.

If we now consider a situation where

- Only one higher efficiency thermal generating plant has been commissioned ; and
- Bell Bay Units 1 and 2 have been decommissioned,

then, in circumstances where fast raise (R6) services cannot be transferred on Basslink, all R6 services will be required to be supplied from Hydro Tasmania plant. A review of the actual availability of these services from Hydro Tasmania when Basslink is out of service has shown that the actual availability rarely exceeds 100 MW (refer figure 1).

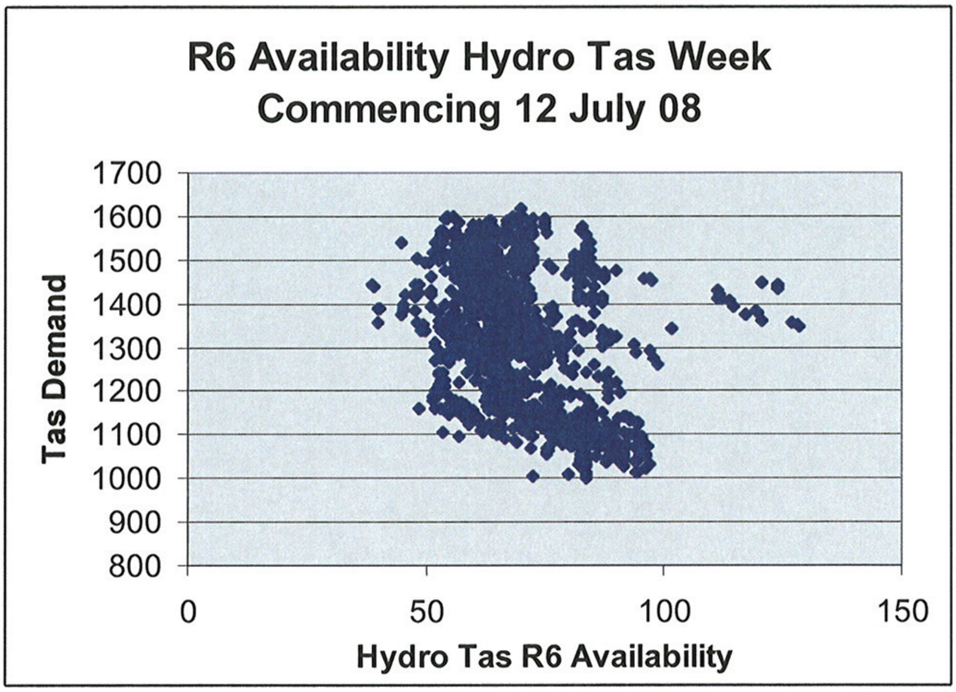

Figure 1 R6 Availability during period when Basslink out of service

However as shown in Attachment 1 the requirement for R6 service to cover the loss of the higher efficiency thermal generating plant (at 210MW) under the standard proposed by Alinta would range from about 304 MW at light load to about 135 MW at high load.

This gap between supply and demand for R6 services might be bridged in part by changes to the commitment strategy by Hydro Tasmania in order to commit more generating units at a given loading level. This would:

- increase the supply of R6 services by having more units on line and having each unit with increased headroom; and
- reduce the requirement by increasing system inertia due to more units being synchronised.[1]

However this would require Hydro Tasmania to significantly deviate from optimum dispatch patterns. In the case of some plant the reductions in output in order to provide additional R6 service would be disproportionate. Such suboptimal operation would likely lead to significant increases in energy prices and may also affect reliability. This is because inefficient operation would reduce the amount of electrical energy that could be generated from a given amount of stored water. In any case hydrological constraints could well prevent dispatch being adjusted to maximise supply of R6 FCAS

In any case whilst such a change in dispatch might be able, at some cost, to allow supply of R6 service to meet the requirement under high load conditions, it would not be able to do so under light load conditions as the maximum level of R6 service that could be provided by

[1] Refer to Attachment 1 which shows the sensitivity of the requirement to changes in inertia

Hydro Tasmania Plant under light load is likely to be between 150 to 200 MW. The increase in system inertia is likely to reduce the requirement by at most 90 MW (ie from about 304 MW to about 214 MW) assuming an increase in inertia of about 1500 MWs[2] which would require the synchronising of at least a further three large hydro generating units.

If the supply of R6 services cannot match the requirement for loss of the higher efficiency thermal generating plant then in order to satisfy the frequency standard the output of this plant would need to be constrained significantly perhaps down to about 140 MW under light load conditions.

There are number of means by which this could be achieved:

A . Reactive Response by NEMMCO to constrain output of the generating unit when a shortage of FCAS is encountered

This approach is not preferred for a number of reasons:

- it could mean that Raise FCAS requirements are not being met for short periods on a regular basis;
- it could result in significant spikes in Raise FCAS prices on a regular basis;
- it could result in market uncertainties due to frequent manual intervention by NEMMCO and
- it may require NEMMCO to issue frequent directions to achieve this .

B. Introduction of Specific Constraints to limit size of largest generator contingency under conditions where supply of Raise FCAS may be restricted

As such an approach would involve applying constraints for a purpose other than directly maintaining power system security then NEMMCO would need clear instructions from the Reliability Panel on the nature of such constraints and the conditions under which such constraints would be allowed to violate if necessary to maintain a secure operating state or a reliable operating state. Such instructions would need to be set out in a manner which was capable of being implemented in the current dispatch algorithm.

C Co-Optimisation of size of largest Generator Contingency and Raise FCAS requirements in the Tasmanian Region.

NEMMCO in its FCAS Review examined the issue of co-optimisation between the size of the largest generator contingency and the FCAS requirement and concluded as follows:

> "Decision 03: The energy target of the largest generating unit (or scheduled load) should theoretically be co-optimised with the cost of meeting the associated contingency FCAS requirement. However, the costs associated with implementing the co-optimisation, coupled with the inability to universally apply the co-optimisation, mean there is no compelling case for change. Consequently this proposal should not be progressed."

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[2] based upon studies detailed in Attachment 1 regarding the sensitivity of requirements to changes in inertia.

However this issue may now represent a situation where a limited introduction of this concept in this special case only could be justified. Such an option would remove most of the difficulties inherent in options A and B above but would create practical difficulties due to the fact that FCAS requirements are calculated on a dynamic basis in the Tasmanian region and the change in the requirement for the same change in the output of the generating unit would differ significantly depending upon demand and system inertia.

D. Introduction of a System Protection Scheme for Higher Efficiency Thermal Generating Plant

Another alternative would be to install a scheme to quickly trip load upon loss of a higher efficiency thermal generating plant[3]. Such a scheme would be similar in concept to the Basslink Frequency Control System Protection Scheme (FCSPS). If available, the operation of such a scheme would be taken into account in determining the R6 requirement for loss of a higher efficiency thermal generating plant thus substantially reducing the requirement. If the load to be shed was of the order of 70 MW then it would be anticipated that there should be little need to constrain the output of the higher efficiency thermal generating plant even under light load conditions. The load to be tripped could be load which is also selected to be tripped by the Basslink FCSPS as each FCAS requirement is determined on the basis that only one credible contingency occurs at a time. This load could also be connected to the under frequency load shedding scheme.

3. Management of Under Frequency following a Non-Credible Contingency Event

The requirement to confine the Tasmanian UFLS settings to the range 48.0 to 47.0 Hz is a challenging requirement and requires careful study of any proposed settings.

The letter from Alinta to the Reliability Panel of 24 July 2008 has addressed in some detail the ability of the proposed UFLS settings to be able handle a 60% supply loss under light load conditions. Further work by Transend has indicated that the current UFLS could be reset with settings confined to between 47.0 and 48.0 Hz to handle a large range of non-credible events.

However NEMMCO's review of this work indicates that that it may not be possible to adequately cover all non-credible contingency events involving 60% of supply at light load conditions as required under Rule 4.3.1 (k) (2). For instance under a scenario where there is loss of Basslink followed by a failure of the Basslink FCSPS and loss of a large thermal unit in Tasmania (or two large hydro units) then frequency could fall below 47.0 Hz leading to the loss of a second large thermal unit.

Also under many scenarios the minimum frequency would be expected to fall close to 47.0 Hz which means that there is very little safety margin which would increase the likelihood of any higher efficiency thermal generating plant tripping.

An alternative approach might be to keep the lower limit of the multiple contingency band at 46.0 Hz. Under this approach any higher efficiency thermal generating plant would not be

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[3] an over frequency interlock would be required to prevent load shedding if the plant tripped due to over frequency

required to operate continuously for low frequencies but would be required to immediately shed up to 210 MW of contracted load in a similar fashion to the Basslink SPS if it tripped due to low frequency.

Such a scheme would be technically feasible using similar technology as the Basslink FCSPS. However there are three issues that would need to be considered:

- for the arrangement to be truly effective, the load to be shed should be load not already connected or required to be connected to Under Frequency Load Shedding (UFLS) Scheme. Such non-critical loads would have to be of the order of 210 MW and would be difficult to find[4]. If the load was instead also connected to the UFLS scheme then such a scheme would be of limited value since it would at best only accelerate the tripping of certain load rather than increase the total amount of load shed. The result would be a significant reduction in the range of non-credible and multiple contingency events for which the UFLS scheme would be effective in preventing system collapse compared to the current range. Even if successful in preventing collapse the transmission network would be, at that point, very lightly loaded which is likely to result in significant risks of overvoltage.
- the higher efficiency thermal generating plant would still not meet the minimum access standard for frequency ride through as required under the Rules.
- A similar requirement would need to be imposed for any subsequent higher efficiency thermal plant. The load required would have to be separate to the load involved in the scheme for the initial higher efficiency thermal generating plant [5]. A further 200 MW of such load would be extremely difficult to obtain.

4. Management of Over Frequency following a Credible Contingency Event

The proposed change in the frequency standard will lower the over frequency range for network events from 50.0 – 53.0 Hz to 50.0 – 52.0 Hz. This would require a very significant increase in fast lower (L6) FCAS requirements.

Such fast lower services have proven difficult to procure under the present arrangements and it is likely to be possible under the proposed arrangements only if there is a substantial increase in the supply of these services. As shown in the studies summarised in Attachment 1 the L6 requirement to cover the most severe normal network contingency under light load conditions with Basslink out of service[6] would increase from about 70 MW under the current standard to about 163 MW under the proposed standard when only one higher efficiency thermal generating plant is in service and to around 179 MW when no higher efficiency thermal generating plants are in service.

As can be seen in Figure 2 the Fast Lower (L6) Service currently available from hydro plant in Tasmania rarely exceeds 100 MW. Thus in circumstances where all higher efficiency

[4] particularly as load should be ideally located close to the generator at risk, to cover events which involve system separation
[5] this is because it is likely that both plants would trip on under frequency during the same event
[6] the L6 requirement would be even higher with Basslink in service and importing but the supply demand situation would be less severe since L6 services could be then sourced from the Mainland but with major limitations on Basslink flow (refer Section 6.3)

plants are either unavailable or not providing lower services then it would be very difficult to meet this requirement under light load conditions.[7]

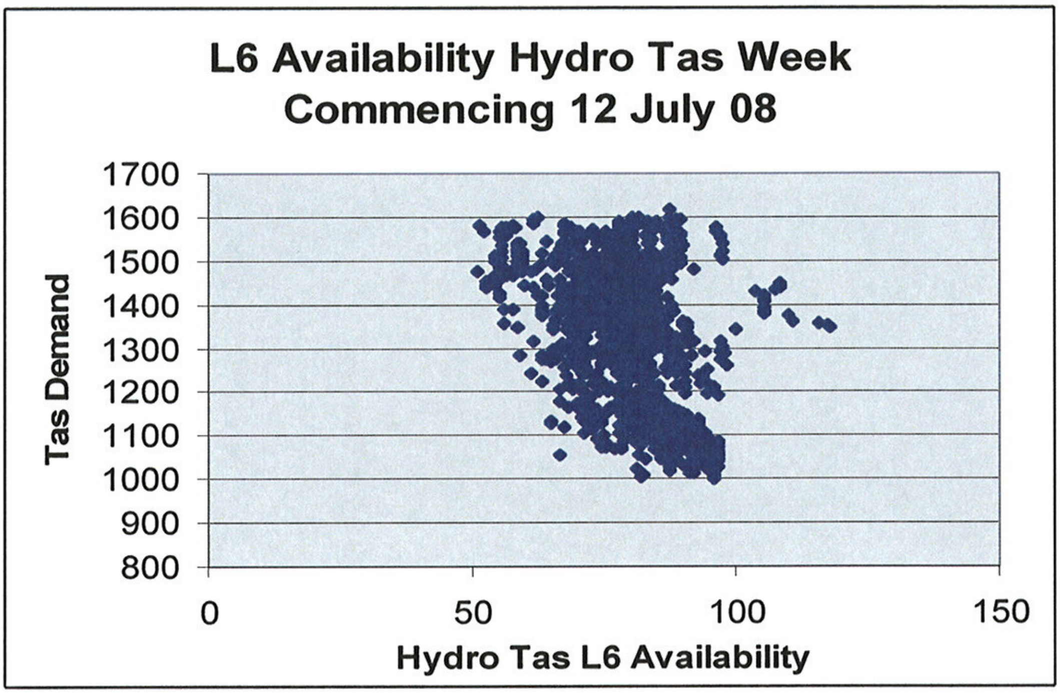

Figure 2 L6 Availability during period when Basslink out of service

NEMMCO thus sees a number of issues which need to be considered:

- The change in the frequency standard does not guarantee that Alinta will actually offer these services ;
- It will be some time before a second higher efficiency plant would be in service and NEMMCO is unaware of any commitment for this second plant to provide lower services; and
- The change in the frequency standard for network events will apply even if all higher efficiency thermal generating plants are out of service.

Even though the likelihood on an outage of a higher efficiency thermal generating plant may be low it is still possible and a coincident outage or blocking of Basslink under light load conditions is also a reasonable possibility. In such a scenario the frequency standard will still apply and NEMMCO will be obliged to use its best endeavours to ensure the standard is met. If available lower services cannot meet the requirement, NEMMCO will have no mechanism under normal processes to reduce the requirement and so NEMMCO may have to direct Hydro Tasmania in such circumstances to synchronise more generating units to increase the inertia. Unless availability of L6 services from Hydro Tasmania plant can be

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[7] this assumes the decommissioning of Bell Bay Units 1 and 2 which would remove two significant providers of fast lower services.

significantly increased then, based upon the studies summarised in Attachment 1, inertia could have to be increased by up to about 1500 MWs to achieve this. This would require synchronisation of 3 or 4 additional large generating units.

5. Management of Over Frequency following a Non- Credible Contingency Event

Such higher efficiency thermal generating plant is apparently unable to operate at frequencies above 52 Hz which might occur following a non-credible contingency event. This issue can be managed under the proposed changes to the frequency standard by incorporating the plant into the over frequency generating shedding scheme (OFGSS) at slightly above 52 Hz.

The same arrangement would have to apply also to all such higher efficiency thermal plant. This then raises two difficulties:

- The submission from Gunns indicates that it is Gunns desire that its plant not remain in service if the frequency goes above 51.6 Hz. However setting of over frequency relays at such a setting might not be possible under the Rules even under the proposed change to the frequency standard. Even if it were possible then it would then be likely that the Gunns plant would trip following a normal credible contingency such as the loss of a single transmission line supplying two potlines.
- There will be a need to set the over frequency tripping for such higher efficiency thermal generating plants slightly above 52 Hz with some time delay to allow proper discrimination.[8] Thus plant would need to be capable of operating to some extent above 52 Hz for short periods. It is unclear whether or not this is feasible.

6. Impact on Basslink Capability

6.1 Flow from Victoria to Tasmania

In the case of restrictions on the import of power into Tasmania there are two possible issues

- *restrictions due to requirements to cover loss of largest unit in Tasmania* – As indicated in Section 2 the R6 requirement to cover the loss of a single higher efficiency thermal generating plant would be difficult to meet from Hydro Tasmania plant alone. If, as per current practice, the output of higher efficiency thermal generating plant was unconstrained by the FCAS equations then an increased level of constraint on Basslink import would be expected in order to maintain enough headroom on Basslink to supply sufficient R6 service from plant on the mainland.
- *restrictions due to need to cover loss of Basslink* – The proposed frequency standard will require tighter performance for loss of Basslink. This increased requirement could be addressed by
    - increasing R6 FCAS requirement for this event – this would likely be less than for the loss of the largest unit ; or

[8] otherwise the simultaneous loss of over 400 MW of generation might then lead to under frequency load shedding

- increasing amount of load connected to FCSPS ; or
- reducing safety margin built into FCSPS operation; or
- most likely some combination of the above.

Any increase in the R6 FCAS requirement for loss of Basslink would be not expected to be the limiting factor on Basslink flow as the requirement of the loss of the largest generating unit is likely to be more significant whenever any one of the higher efficiency thermal generating plants was operating above about 150MW.

The restrictions on import on Basslink would be more clearly pronounced under light conditions due to the sharp rise in R6 requirements for loss of a single higher efficiency thermal generating plant under these conditions assuming the output of this plant does not reduce during light load conditions.

If would be difficult to quantify these over the full range of operating conditions. Thus this question could only be addressed on a scenario by scenario basis.

For instance if we look at a scenario where

- Tasmania is facing an energy shortage due to low water storage levels;
- Hydro Tasmania operating its system at optimum efficiency to maximise use of stored water with R6 FCAS availability thus limited to about 100 MW;
- A single higher efficiency thermal generating plant is at continuous full output:
- Bell Bay Units 1 and 2 are decommissioned and no other higher efficiency thermal generating plant has yet been commissioned ; and
- Basslink is being operated to maximise import throughout the day subject to meeting FCAS requirements;

Then, to ensure increased raise requirements could be provided, Basslink would be expected to be constrained compared to the current situation[9] by

- about an additional 340 MW under light load conditions;
- about an additional 105 MW under average load conditions; and
- about an additional 33 MW under high load conditions.

Under this scenario this would represent a total additional constraint on energy supply across Basslink compared to the current situation of about 3.5 GWhrs a day.

Alternatively if the output of the single higher efficiency thermal generating plant is restricted to, say, 144 MW then Basslink would be expected to be constrained compared to the current situation[10] by

- about an additional 52MW under light load conditions;
- no additional restriction under average load conditions; and
- no additional restriction under high load conditions.

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[9] that is the current frequency operating standard and maximum generating unit contingency of 144 MW for R6 requirements

[10] that is the current frequency operating standard and maximum generating unit contingency of 144 MW for R6 requirements

Under this second scenario this would represent a total additional constraint on energy supply across Basslink compared to the current situation[10] of about 0.3 GWhrs a day. It should be noted that a reduction in output of this single higher efficiency thermal generating plant from 210 MW to 144 MW would represent a reduction in energy supply from non-hydro sources of about 1.6 GWhrs a day.

It should be noted that the figures above are indicative only and apply only for these extreme scenarios. The effect under other less extreme scenarios would be less.

6.2 Flow from Tasmania to Victoria

In the case of the restrictions on the export of power from Tasmania, the proposed frequency standard will considerably tighten the required frequency response for loss of Basslink. This increased requirement could be met by

- increasing L6 FCAS requirement for this event – as maximum export could occur only when a large number of units are committed in the Tasmanian region then sourcing this extra requirement should not present a significant issue provided some higher efficiency thermal generating plant were also prepared to offer this service. However this could result in increased costs to Market Customers; or
- increasing the amount of generation connected to FCSPS; or
- reducing the safety margin built into FCSPS operation; or
- most likely, some combination of the above

The level of restrictions on Basslink export, if any, may depend heavily on whether any higher efficiency thermal generating plant provide fast lower service or are connected for tripping from the Basslink FCSPS. If this is not the case then there would be very significant restrictions unless there is a significant increase in the availability of L6 services from hydro generating units.

6.3 Flexibility of Basslink Operation

Recent changes have been introduced to NEMDE to reduce instances of "stranding" of Basslink. There are two important characteristics of Basslink that can cause NEMDE to be unable to find the optimal solution in a significant number of Dispatch Intervals:

- No-go Zone - NEMDE is a linear program, and will attempt to produce dispatch targets anywhere in the no-go zone if demanded by the market conditions.
- FCAS Transfer Capability - when operating at levels greater than 50MW in either direction, Basslink has the capability to transfer FCAS from one region to another. This allows, for example, the FCAS requirement for the Tasmanian region to be met in part by scheduling additional FCAS on the mainland, if it is economical to do so.

The aforementioned FCAS transfer capability is modelled in NEMDE by a set of constraints to ensure that only valid dispatch solutions are in the allowed solution space. One of these constraints ensures that, if the Basslink frequency controller is switched on and the initial dispatch is greater than 50MW, then the dispatch solution for the next run must also be at least 50MW in the same direction. Allowing a solution of less than 50MW would invalidate the dispatch of FCAS across Basslink for some part of the dispatch interval. This arrangement does not consider the possible economic benefit gained by reversing the flow direction of the Basslink flow.

Due to this, NEMDE has been modified to perform two runs for every dispatch interval. The first run uses the SCADA indication for the status of the Basslink frequency controller and for the additional NEMDE run the input status of the Basslink frequency controller is assumed to be switched off. i.e. if the Basslink frequency controller is turned off, the two runs are identical.

The final solution and the associated NEMDE input status of the Basslink frequency controller is decided by selecting the run with the least cost objective function.

This allows

- NEMDE to increase the set of allowable dispatch outcomes that satisfy the complex model of Basslink available to NEMDE so that it can maximise the value of spot market trade, as required under National Electricity Rule 3.8.1(a).
- A reduction in unnecessary counter price flows across the Basslink HVDC interconnector.

However it should be noted that Basslink can still be scheduled to flow counter-price if this result maximises the value of spot market trading in accordance with Rule 3.8.1. The proposed changes to the frequency standard will increase the FCAS requirements and it is likely that the incidence of such events will rise due to the increased demand for FCAS.

If such an event occurs then in some instances the flow could be reversed by rebidding of energy or FCAS offers in the Tasmania Region but this is possible only if there is an adequate supply of FCAS within the Tasmanian Region to meet all credible contingency events in Tasmania. This may not always be the case under lighter load conditions (refer Sections 2 and 4 above).

Under light load conditions there will be high requirements for both R6 and L6 services. For instance if we consider the following scenario:

- Basslink in service and importing
- A single higher efficiency thermal generating plant operating at 210 MW but not offering L6 services
- Bell Bay Units 1 and 2 decommissioned or out of service
- Hydro Plant in service capable of supplying only 100MW of both R6 and L6 services

Then to meet these requirements Basslink would have to be operated with at least 370 MW of raise head room and 120 MW of lower head room. However such simultaneous requirements would be incompatible.

However if this single higher efficiency thermal generating plant was operating at say 144 MW or was providing about 70 MW of L6 service then there would be a compatible range of operation but it would still be considerably more restrictive than at present.

7. Discrimination between Basslink FCSPS and UFLS Scheme

Studies undertaken by Hill Michael and Transend have demonstrated that with appropriate settings adequate discrimination between the Basslink System protection Scheme and the Tasmanian UFLS scheme should be able to be achieved.

8. Impact on Reliability

Reliability issues in the foreseeable future for Tasmania are far more likely to arise due to energy shortages rather than capacity shortages.

If the commissioning of Alinta plant also means decommissioning of Bell Bay 1 and 2 units then the net impact on energy supply should be small. However as shown in Section 6.1, the impact of the larger size of the Alinta plant and the proposed tighter frequency operating standard might well impact on the import capability of Basslink thus reducing energy supply from the mainland.

An assessment of the additional impact of the Gunns generating plant on reliability would need to take into account also the increased load due to the Gunns industrial plant. The net effect on energy availability would be of the order of 480 GWhrs per annum which is equivalent to about 3.3 % of maximum Hydro Tasmania water storage or about 4.8 % of annual Tasmanian Energy. Such a contribution could be significant during periods of prolonged drought

9. Future System Developments

Studies conducted by Hill Michael are based upon the assumption that there will be one further large wind farm in Tasmania located well away from Woolnorth. However if there are more wind farms then this could be a significant issue under light load conditions due to the fact that wind generators with a low inertia may replace other generating units with higher inertia thus lowering the inertia even further than present values and consequently increasing fast lower and raise requirements[11]. The degree of impact will depend to some extent on the geographic diversity of any new wind farms compared to each other and to existing wind farms. This could also be an issue, though a smaller one, under the existing frequency operating standards.

The studies summarised in Attachment 1 show the sensitivity of the contingency FCAS requirements to changes in inertia.

These results show that a 500 MWs increase in inertia will reduce the critical fast raise FCAS requirement under the Alinta proposal by 30 MW at light load (about 10% reduction) but only 2 MW at peak load. There are similar but slightly smaller impacts on the slow raise requirement and virtually no impact on the delayed raise requirement.

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[11] Refer Attachment 2 showing current relationship between Demand and System Inertia

These results also show that a 500 MWs increase in inertia will reduce the critical fast lower (L6) FCAS requirement under the Alinta proposal by 14 MW at light load (about an 8% reduction) but only 1 MW at peak load. In this case the actual slow lower requirement increases slightly due to the fact that the fast lower requirement is reduced. However the combined total is less. There is no impact on the delayed lower requirement. An increase of 500 MWs in the inertia would represent the synchronisation of one additional large unit such as a Reece unit or two smaller generating units.

Thus an increase in inertia will tend to reduce the overall requirements for FCAS contingency services under light load conditions and hence the costs of these services assuming no changes in offer prices.

It is thus possible that operation of some hydro generating units in synchronous condenser mode may alleviate this problem. There are 14 generating units in the Tasmanian Region potentially capable of operating in synchronous condenser mode with a total potential contribution to inertia of 4707 MWs.

However there is currently no mechanism to determine a requirement, procure and dispatch the service or to recover the cost of the service which could be significant. This service is not recognised as a non-market ancillary service under the Rules.

10. Definition of Island Operation under the Frequency Operating Standard

In the previous determination made by the Reliability Panel on 28 May 2006 regarding the Tasmanian Frequency Operating Standard an island was defined as follows:

"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"

NEMMCO interprets this to mean that the term island refers to a part of the Tasmanian System not the entire Tasmanian system and thus the "island operation" standard should apply only to a part of the Tasmanian system when it is separated from the remainder of the Tasmanian System. However in many cases due to severe imbalances between supply and demand in such potential islands, it would be impossible to meet the requirements of the standard in such cases. In order to avoid creating unrealistic expectations, NEMMCO suggests that the definition of an island in this context be suitably qualified.

Submissions from Generators to the Reliability have proposed that the upper limit of the separation event band under Islanded Operation be reduced from 60.0 Hz to 55.0 Hz. NEMMCO has no objection to this provided that it is accepted that such a change will mean that over frequency generator shedding schemes will be less able to effectively manage islanding events within the Tasmanian region where an island is formed with a substantial excess of generation.

11. Frequency Regulation

On the assumption that there will be no change required to the normal frequency operating bands or to the time error limits then NEMMCO does not envisage that there would be any change to the requirements for regulating services within Tasmania.

It should be noted that, as at present, NEMMCO would not expect to be required to maintain the time error within the required 15 second limit in the period immediately following a non-credible contingency event.

12. Conclusion

NEMMCO has examined the technical implications of a change to the Tasmanian Frequency Operating Standard in order to accommodate the technical limitations of higher efficiency thermal generating plant as set out in the introduction.

NEMMCO's conclusion is that such a change is only possible if

(d) measures are put in place to limit the size of the largest generator event down to about 144 MW in conditions where Raise FCAS is in short supply;

(e) at least the first two higher efficiency thermal generating plants offer fast lower services (of the order of 70MW each); and

(f) suitable settings for over frequency tripping of all higher efficiency thermal generating plant can be agreed to ensure adequate grading.

There may also be a requirement for higher efficiency thermal generating plant to be connected to the Basslink SPS to maintain the current levels of transfer capability from Tasmania to Victoria.

However, even if these conditions are met, such a change in the frequency operating standard will still create a number of issues as follows:

i) there will be a reduction in the range of non-credible events that could be effectively managed by the UFLS scheme meaning that NEMMCO may not be able to meet the requirements of Rule 4.3.1(k)(2) as well as it does presently ;
ii) there will be difficulties in meeting the lower FCAS requirements for normal network events during light low periods when Basslink is out of service or blocked and no higher efficiency thermal generating plant is available which may require significant intervention by NEMMCO unless there is a large increase in the availability of L6 services provided by hydro generating units[12];
iii) there will be additional restrictions on the import capability of Basslink under lighter load conditions which may reduce the ability of the new gas fired base load plant to address energy shortages due to low hydro storage levels;
iv) the operational flexibility of Basslink will be reduced during light load periods; and
v) there will be an increase in difficulties if there is significant further development of wind farms which may then require some structured process to manage the level of system inertia in Tasmania.

These issues will be most significant in the period between commissioning of the first of the higher efficiency thermal generating plant and the commissioning of the second such plant. However the issues will still remain to a lesser extent following the commissioning of this second plant.

[12] This assumes that the 120 MW Bell Bay Units are decommissioned. If this were not to be the case and at least one such unit was in service and providing L6 services during light load conditions then the situation would be significantly improved.

NEMMCO also notes the submission from Gunns which suggests an even tighter standard for over frequency events. This would create greater problems under light load conditions.

Attachment 1 - Tasmanian FCAS requirements for proposed Frequency Standards

NEMMCO does not anticipate that these proposals would result in any changes to raise or lower regulation requirements.

The following are NEMMCO estimates of requirements for contingency raise and lower services as follows

- raise contingency services for both current Frequency Operating Standard and for the Alinta proposal with
  - either Basslink out of service or blocked ; or
  - Basslink in service at a level of flow typical for that level of Tasmanian Demand.
- lower contingency services for the current Frequency Operating Standard, the Alinta proposal and the Gunns proposal with
  - Alinta in service and Gunns not commissioned and
  - either Basslink out of service or blocked ; or
  - Basslink in service at a level of flow typical for that level of Tasmanian Demand.
- lower contingency services for the current Frequency Operating Standard, the Alinta proposal and the Gunns proposal with
  - all higher efficiency thermal generating plant out of service and
  - either Basslink out of service or blocked ; or
  - Basslink in service at a level of flow typical for that level of Tasmanian Demand

Each case has been re-run with inertia increased by 500 MWs and reduced by 500 MWs to show the sensitivity of the requirement to changes in inertia.

The base case post – contingent inertia has been determined assuming a single higher efficiency thermal generating plant is in service and the 120 MW Bell Bay units are decommissioned. This has been achieved by:

- Taking an actual demand/inertia case
- Determining how many 120 MW Bell Bay units are in service
- Amending the actual inertia using the appropriate approach outlined below.
- To determine the FCAS raise requirement to cover the loss of the largest unit it is assumed the unit is the Alinta CCGT with inertia of 1720 MW.s. The inertia determined in the previous step is reduced by 1720 MW.s for these scenarios.

- **If largest unit is 144 MW**[13]
  - Reducing the actual inertia by 1350 MW.s if both Bell Bay units in service

[13] 144 MW has been chosen as this is the size of the current largest generator event which sets the R6 requirement. The loss of both Bell Bay Units has been reclassified as a credible event for R60 and R5 requirements but not R6 requirements as the tripping of the second unit is expected to occur sometime after the tripping of the first unit.

- Reducing the actual inertia by 752 MW.s if one Bell Bay unit is in service (equivalent to the inertia of 1 Bell Bay unit + 1 Catagunya unit)
- Increasing the revised inertia by 1797 MW.s to account for the additional inertia from the Alinta CCGT plus OCGT.

- **If largest unit is 210 MW**
  - Reducing the actual inertia by 1682 MW.s if both Bell Bay units in service (equivalent to the inertia of 2 Bell Bay units + 1 Bastyan unit)
  - Reducing the actual inertia by 1344 MW.s if one Bell Bay unit is in service (equivalent to the inertia of 1 Bell Bay unit + 1 Bastyan unit + 1 Cethana unit)
  - Increasing the revised inertia by 1797 MW.s to account for the additional inertia from the Alinta CCGT plus OCGT.

- **Trip of two potlines – Alinta in service**
  - Reducing the actual inertia by 1682 MW.s if both Bell Bay units in service (equivalent to the inertia of 2 Bell Bay units + 1 Bastyan unit)
  - Reducing the actual inertia by 1344 MW.s if one Bell Bay unit is in service (equivalent to the inertia of 1 Bell Bay unit + 1 Bastyan unit + 1 Cethana unit)
  - Increasing the revised inertia by 1797 MW.s to account for the additional inertia from the Alinta CCGT plus OCGT.

- **Trip of two potlines – Alinta out of service**
  - Reducing the actual inertia by 1350 MW.s if both Bell Bay units in service (equivalent to the inertia of 2 Bell Bay units)
  - Reducing the actual inertia by 675 MW.s if one Bell Bay unit is in service (equivalent to the inertia of 1 Bell Bay unit)
  - Increasing the revised inertia by 1252 MW.s (equivalent to the inertia of 2 Gordon units) as a replacement for the Alinta units.

1. Raise FCAS requirement to cover loss of the largest generating unit

Basslink OOS or Blocked: Gen loss = 144 MW

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**5125**	**5570**	**7025**	**7927**
R6 (47.5)	93	88	67	48
R60 (47.5)	117	109	84	60
R5 (47.5)	143	143	142	142
R6 (48)	110	101	82	66
R60 (48)	138	126	102	83
R5 (48)	142	142	141	141

Basslink OOS or Blocked: Gen loss = 144 MW: Inertia +500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**5625**	**6070**	**7525**	**8427**

R6 (47.5)	92	87	67	48
R60 (47.5)	115	108	83	60
R5 (47.5)	143	143	143	142
R6 (48)	105	99	81	66
R60 (48)	131	124	102	82
R5 (48)	142	142	142	141

Basslink OOS or Blocked: Gen loss = 144 MW: Inertia -500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**4625**	**5070**	**6525**	**7427**
R6 (47.5)	95	89	68	49
R60 (47.5)	119	111	85	61
R5 (47.5)	142	142	142	141
R6 (48)	122	106	83	67
R60 (48)	153	133	103	83
R5 (48)	141	141	141	141

Basslink OOS or Blocked: Gen loss = 210 MW

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**4533**	**4978**	**6433**	**7595**
R6 (47.5)	223	194	135	113
R60 (47.5)	279	244	169	141
R5 (47.5)	204	205	207	207
R6 (48)	304	268	181	135
R60 (48)	380	336	227	169
R5 (48)	200	201	205	206

Basslink OOS or Blocked: Gen loss = 210 MW: Inertia +500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**5033**	**5478**	**6933**	**8095**
R6 (47.5)	201	177	133	112
R60 (47.5)	251	221	167	140
R5 (47.5)	205	206	208	207
R6 (48)	274	244	168	133
R60 (48)	343	305	210	166
R5 (48)	201	202	206	206

Basslink OOS or Blocked: Gen loss = 210 MW: Inertia -500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**4033**	**4478**	**5933**	**7095**
R6 (47.5)	251	217	138	113
R60 (47.5)	314	271	172	142
R5 (47.5)	203	205	207	207

R6 (48)	342	298	197	142
R60 (48)	428	373	246	177
R5 (48)	199	201	204	206

Basslink in service: Gen loss = 144 MW

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**3227**	**3925**	**6027**	**8625**
R6 (47.5)	123	94	68	48
R60 (47.5)	154	118	85	60
R5 (47.5)	141	142	142	142
R6 (48)	175	137	84	65
R60 (48)	219	171	104	82
R5 (48)	139	140	141	141

Basslink in service: Gen loss = 144 MW: Inertia +500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**3727**	**4425**	**6527**	**9125**
R6 (47.5)	106	91	68	47
R60 (47.5)	133	113	84	59
R5 (47.5)	142	142	142	142
R6 (48)	152	121	83	65
R60 (48)	190	152	103	81
R5 (48)	140	141	141	141

Basslink in service: Gen loss = 144 MW: Inertia -500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**2727**	**3425**	**5527**	**8125**
R6 (47.5)	146	108	69	48
R60 (47.5)	182	135	86	60
R5 (47.5)	140	141	142	142
R6 (48)	208	157	85	66
R60 (48)	259	196	106	82
R5 (48)	138	139	141	141

Basslink in service: Gen loss = 210 MW

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**2895**	**3333**	**5695**	**8033**
R6 (47.5)	350	291	142	112
R60 (47.5)	437	364	178	140
R5 (47.5)	201	203	207	207
R6 (48)	477	401	205	133
R60 (48)	596	501	256	167

R5 (48)	197	199	204	206

Basslink in service: Gen loss = 210 MW: Inertia +500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**3395**	**3833**	**6195**	**8533**
R6 (47.5)	298	253	136	111
R60 (47.5)	373	316	170	139
R5 (47.5)	202	203	207	207
R6 (48)	406	349	188	132
R60 (48)	508	436	235	165
R5 (48)	198	200	205	206

Basslink in service: Gen loss = 210 MW: Inertia -500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**2395**	**2833**	**5195**	**7533**
R6 (47.5)	423	343	156	113
R60 (47.5)	528	428	195	141
R5 (47.5)	200	202	206	207
R6 (48)	576	472	225	136
R60 (48)	720	590	281	169
R5 (48)	196	198	203	206

2. Lower FCAS requirement to cover loss of two Comalco potlines

Note: L6 discount factor is 0.4 for 53 Hz. The L6 discount factor for the 52 Hz and 51.6 Hz operating standards have been calculated assuming a linear relationship between 0.4 at 53 Hz and 1.0 at 51 Hz. The factors are therefore: 0.7 at 52 Hz and 0.82 at 51.6 Hz. [14]

Basslink OOS or Blocked: Alinta in service

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**6253**	**6698**	**8153**	**9315**
L6 (53)	60	56	43	31
L60 (53)	213	212	208	203
L5 (53)	212	212	211	210
L6 (52)	163	148	109	93
L60 (52)	186	191	196	190
L5 (52)	214	213	212	211
L6 (51.6)	257	234	174	137

[14] Note this is an initial assumption by NEMMCO and would need to be confirmed with Hydro Tasmania as the principal provider of L6 services

L60 (51.6)	161	168	181	182
L5 (51.6)	215	215	212	211

Basslink OOS or Blocked: Alinta in service: Inertia +500

Tas D	900	1000	1400	1800
Tas I	**6753**	**7198**	**8653**	**9815**
L6 (53)	59	55	42	30
L60 (53)	215	214	210	205
L5 (53)	212	212	211	210
L6 (52)	151	137	107	92
L60 (52)	192	195	197	191
L5 (52)	214	213	212	211
L6 (51.6)	238	218	164	130
L60 (51.6)	166	173	184	184
L5 (51.6)	215	215	212	211

Basslink OOS or Blocked: Alinta in service: Inertia -500

Tas D	900	1000	1400	1800
Tas I	**5753**	**6198**	**7653**	**8815**
L6 (53)	61	58	44	32
L60 (53)	210	210	206	201
L5 (53)	212	212	211	210
L6 (52)	177	160	113	95
L60 (52)	181	186	193	189
L5 (52)	214	213	212	211
L6 (51.6)	279	253	185	144
L60 (51.6)	156	164	178	180
L5 (51.6)	216	215	212	211

Basslink in service: Alinta in service:

Tas D	900	1000	1400	1800
Tas I	**4615**	**5053**	**7415**	**9753**
L6 (53)	71	62	45	30
L60 (53)	202	204	205	204
L5 (53)	213	212	211	210
L6 (52)	221	195	117	92
L60 (52)	170	176	192	191
L5 (52)	214	214	212	211
L6 (51.6)	348	310	191	130
L60 (51.6)	145	154	176	184
L5 (51.6)	215	215	212	211

Basslink in service: Alinta in service: Inertia +500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**5115**	**5553**	**7915**	**10253**
L6 (53)	64	59	44	29
L60 (53)	207	207	207	206
L5 (53)	213	212	211	210
L6 (52)	145	178	110	91
L60 (52)	175	181	195	192
L5 (52)	214	214	212	211
L6 (51.6)	213	282	179	127
L60 (51.6)	150	158	179	185
L5 (51.6)	215	215	212	211

Basslink in service: Alinta in service: Inertia -500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**4115**	**4553**	**6915**	**9253**
L6 (53)	80	68	46	31
L60 (53)	197	200	203	202
L5 (53)	213	213	211	210
L6 (52)	248	217	125	93
L60 (52)	166	172	189	190
L5 (52)	214	214	212	211
L6 (51.6)	390	344	205	138
L60 (51.6)	141	150	173	182
L5 (51.6)	215	214	212	211

Basslink OOS or Blocked: Alinta out of service

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**5708**	**6153**	**7608**	**8770**
L6 (53)	62	58	44	32
L60 (53)	210	210	206	200
L5 (53)	212	212	211	210
L6 (52)	179	160	114	95
L60 (52)	181	186	193	189
L5 (52)	214	213	212	211
L6 (51.6)	281	255	186	145
L60 (51.6)	156	163	177	180
L5 (51.6)	216	215	212	211

Basslink OOS or Blocked: Alinta out of service: Inertia +500

Tas D	**900**	**1000**	**1400**	**1800**

Tas I	6208	6653	8108	9270
L6 (53)	60	56	43	31
L60 (53)	212	212	208	202
L5 (53)	212	212	211	210
L6 (52)	165	148	109	93
L60 (52)	186	190	195	190
L5 (52)	214	213	212	211
L6 (51.6)	258	235	175	137
L60 (51.6)	161	168	180	182
L5 (51.6)	216	215	212	211

Basslink OOS or Blocked: Alinta out of service: Inertia -500

Tas D	900	1000	1400	1800
Tas I	**5208**	**5653**	**7108**	**8270**
L6 (53)	64	59	45	33
L60 (53)	207	207	204	199
L5 (53)	213	212	211	210
L6 (52)	196	175	122	96
L60 (52)	176	181	190	188
L5 (52)	214	214	212	211
L6 (51.6)	308	277	199	154
L60 (51.6)	151	159	175	177
L5 (51.6)	215	215	212	211

Basslink in service: Alinta out of service:

Tas D	900	1000	1400	1800
Tas I	**4070**	**4508**	**6870**	**9208**
L6 (53)	81	69	46	31
L60 (53)	196	200	203	202
L5 (53)	213	213	211	210
L6 (52)	251	219	126	93
L60 (52)	165	172	189	190
L5 (52)	214	214	212	211
L6 (51.6)	394	348	207	139
L60 (51.6)	141	150	173	182
L5 (51.6)	215	214	212	211

Basslink in service: Alinta out of service: Inertia +500

Tas D	900	1000	1400	1800
Tas I	**4570**	**5008**	**7370**	**9708**

L6 (53)	72	62	45	30
L60 (53)	201	204	205	204
L5 (53)	213	212	211	210
L6 (52)	223	197	118	92
L60 (52)	170	176	192	191
L5 (52)	214	214	212	211
L6 (51.6)	351	313	193	131
L60 (51.6)	145	154	176	184
L5 (51.6)	215	215	212	211

Basslink in service: Alinta out of service: Inertia -500

Tas D	**900**	**1000**	**1400**	**1800**
Tas I	**3570**	**4008**	**6370**	**8708**
L6 (53)	92	78	47	32
L60 (53)	191	195	201	200
L5 (53)	213	213	211	210
L6 (52)	286	246	136	95
L60 (52)	161	168	186	188
L5 (52)	214	214	212	211
L6 (51.6)	449	391	222	146
L60 (51.6)	137	146	170	179
L5 (51.6)	215	214	212	211

Attachment 2 - *Current Relationship between Demand and Inertia in the Tasmanian Region*

The total inertia for Tasmanian generally increases with demand but is also dependent on status of Basslink and the number and type of generating units synchronised. The following graphs show the different patterns for differing conditions.

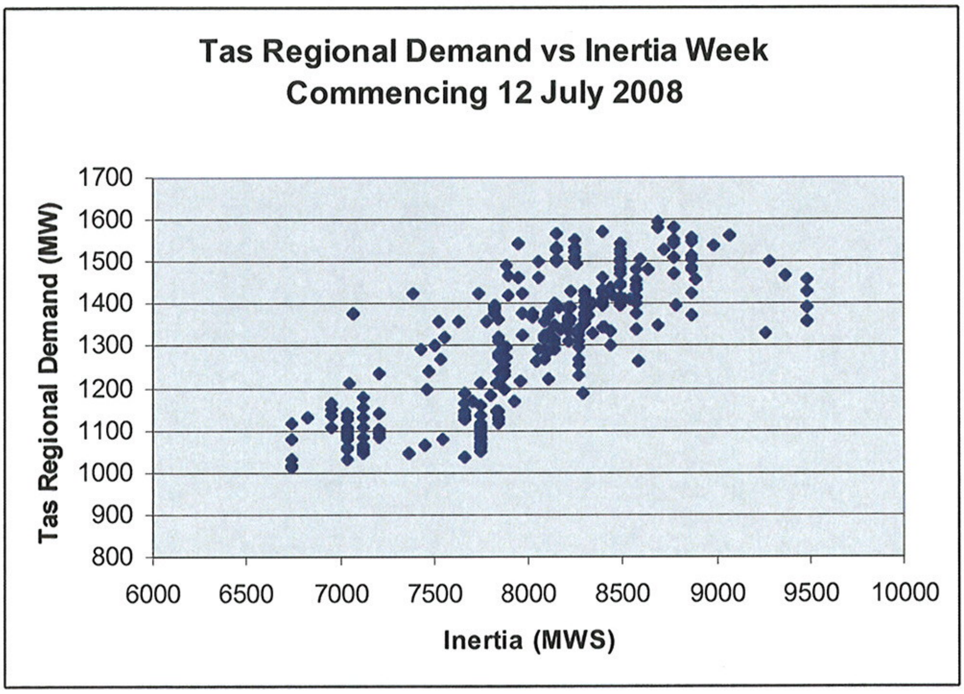

Figure 2 Relationship between Inertia and Regional for a Period when Basslink is out of service

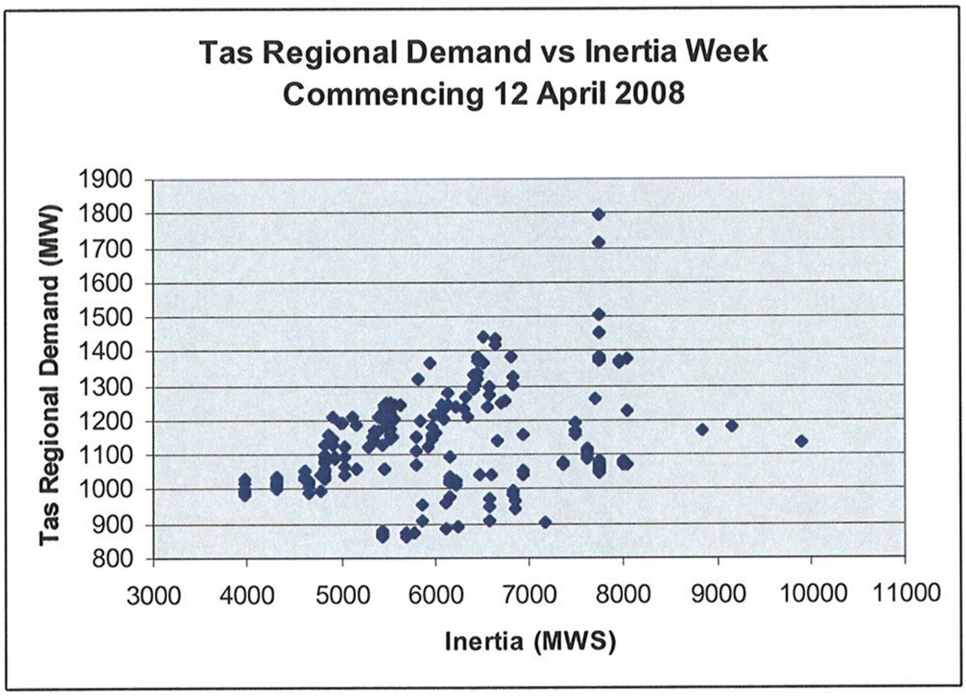

Figure 3 Relationship between Inertia and Regional for a Period when Basslink is in service

The figures show that the inertia at light loads is considerably lower when Basslink is in service. This is understandable as Basslink when in service is generally flowing heavily into Tasmania during light load conditions. It should be noted that the inertia values above are for the existing system and include contribution when, in service, of the Bell Bay Units 1 and 2 but not contributions from any future higher efficiency thermal generating plant.