POWER SYSTEM FREQUENCY AND TIME DEVIATION MONITORING

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Contents

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2 Introduction

AEMO is required to maintain the power system frequency and time deviation within the limits specified in the frequency operating standards determined for the Mainland and the Tasmania Region by the Reliability Panel. This document reports on the frequency and time deviation performance observed during January 2012 in all regions of the NEM. Regions QLD, NSW, VIC and SA will be referred to as the Mainland regions throughout the report.

The frequency operating standards for the Mainland regions and the Tasmania region are available on the AEMC web site[1].

The "Power System Frequency and Time Deviation Monitoring Report – Reference Guidelines[2]" outlines the calculation processes used by AEMO in the preparation of the monthly Power System Frequency and Time Deviation Monitoring reports.

The analysis of the delivery of slow raise service, slow lower service, delayed raise service and delayed lower service presented in this report are based on 4-second resolution data. Data for Mainland regions is sourced from the Sydney PI server and data for Tasmania region is sourced from the Brisbane PI server. The analysis of fast raise service and fast lower service delivered is based on high-speed (50 ms or higher resolution) data and is only presented in this report for events where the appropriate data is available.

Table 1 below summarises events in the Mainland and Tasmanian regions for the month January 2012 with frequency excursions outside the normal operating frequency band. Any events in Table 1 that are identified with frequency excursions that did not meet the frequency operating standards are evaluated in section 4 of the report.

[1] The frequency operating standards for the Mainland and Tasmania regions are available from http://www.aemc.gov.au/Panels-and-Committees/Reliability-Panel/Guidelines-and-standards.html

[2] The Power System Frequency and Time Deviation Monitoring Report – Reference Guide is available from http://www.aemo.com.au/en/Electricity/Market-and-Power-Systems/NEM-Reports/Power-System-Performance-Monitoring

3 Summary of Events

Table 1: Events in the Mainland and Tasmanian regions with frequency excursions outside the normal frequency operating band.

EVENT	LOW/HIGH FREQUENCY EVENT	NUMBER OF EVENTS	
		MAINLAND	TASMANIA
No contingency or load event/Normal event	LOW	**0**	**92**
	HIGH	**0**	**18**
Load Event	LOW	**0**	**71**
	HIGH	**0**	**168**
Generation Event	LOW	**5**	**4**
	HIGH	**0**	**0**
Network Event	LOW	**0**	**1**
	HIGH	**0**	**1**
Separation Event	LOW	**0**	**1**
	HIGH	**0**	**0**
Multiple Contingency Event	LOW	**0**	**0**
	HIGH	**0**	**0**

4 Events in the Mainland and Tasmania Regions that did not meet the Frequency Operating Standards

In this section, details are provided of those events identified in Table 2 as not meeting the frequency operating standard applicable to each event.

4.1 Frequency Events in Mainland Regions

There were no events recorded in Mainland Regions that did not meet the Mainland Frequency Operating Standards from those identified in Table 3 during January 2012.

4.2 Low Frequency Events in Tasmania

There were fourteen Low Frequency Normal Condition Events from Table 1 recorded in Tasmanian region during January 2012 that resulted in frequencies below 49.75 Hz. All of these events listed in Table 4 did not meet the Tasmania Frequency Operating Standards. Please note that there is one Low and High Frequency Normal Condition Event on the 22nd Jan 2012.

Table 5: Low Frequency Normal Events in the Tasmania region resulting in frequency outside the Tasmania Frequency Operating Standards

DATE	EVENTS	MIN FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)
5/01/2012 03:53:28	No condition causing the event was identified.	49.73	56
7/01/2012 00:40:48	No condition causing the event was identified.	49.74	24
10/01/2012 20:10:20	No condition causing the event was identified.	49.73	260
13/01/2012 04:16:08	No condition causing the event was identified.	49.61	302
13/01/2012 04:53:36	No condition causing the event was identified.	49.52	400
13/01/2012 18:37:08	No condition causing the event was identified.	49.59	606
13/01/2012 22:09:00	No condition causing the event was identified.	49.62	96
14/01/2012 21:27:56	No condition causing the event was identified.	49.68	40

20/01/2012 19:56:28	No condition causing the event was identified.	49.68	96
22/01/2012 19:08:52[3]	No condition causing the event was identified.	49.68	68
24/01/2012 03:53:20	No condition causing the event was identified.	49.69	136
27/01/2012 06:58:16	No condition causing the event was identified.	49.63	100
27/01/2012 19:37:56	No condition causing the event was identified.	49.67	20
30/01/2012 02:15:00	No condition causing the event was identified.	49.74	28

[3] Please note that in this Normal Condition Event, there was one Low and High Frequency excursion. This event is elaborated in Section 4.3.

4.2.1 Event: 05/01/2012 03:53:28

For the Normal (Non-Contingency) low frequency event on 5th Jan 2012 in Tasmania, Figure 1 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 56 seconds. One Tasmanian generating unit ramped down below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, some slow raise FCAS was delivered by some units providing a negative response as shown in Figure 2. The flow across Basslink was approximately 470 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.72 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

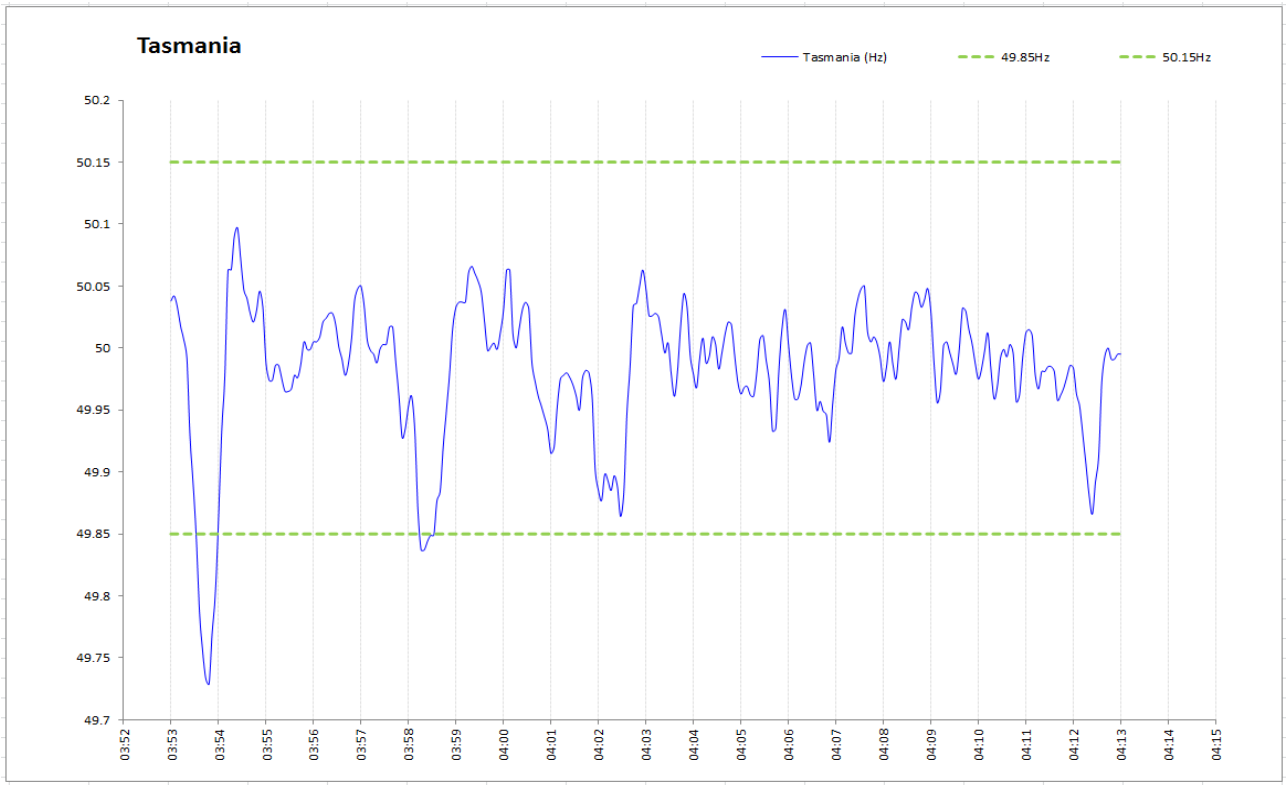

Figure 1: Low Frequency Normal Event in Tasmania refer to item 1 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

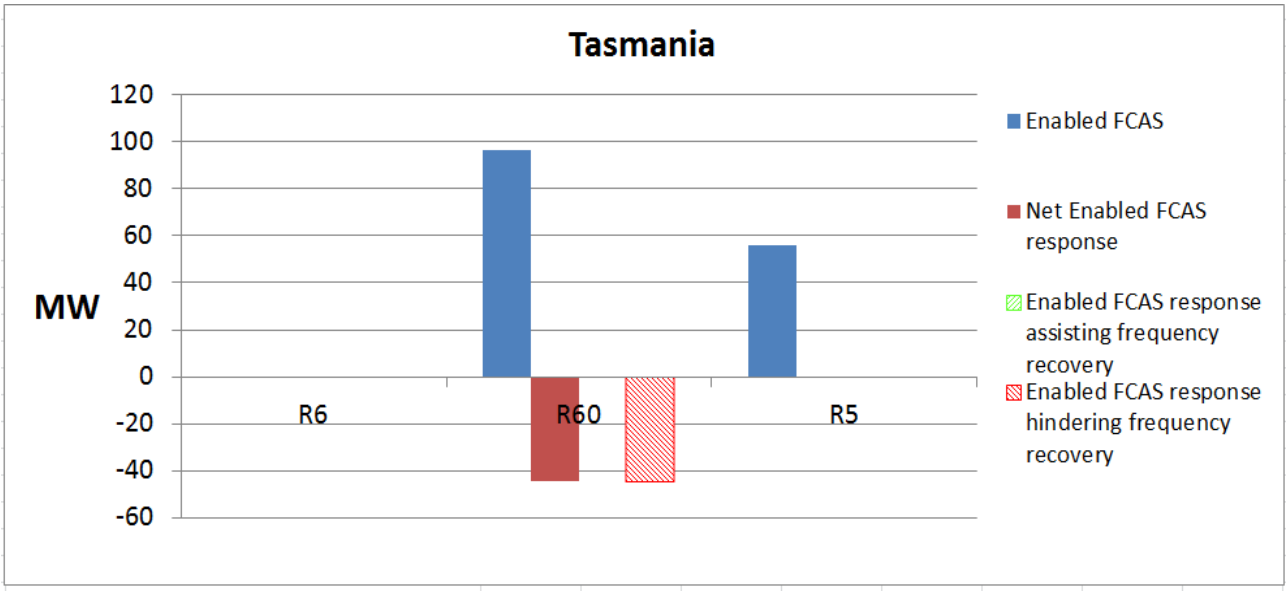

Figure 2: FCAS response to Normal (Non-Contingency) Low Frequency Event on 5th Jan 2012.

4.2.2 Event: 07/01/2012 00:40:48

For the Normal (Non-Contingency) low frequency event on 7th Jan 2012 in Tasmania, Figure 3 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 24 seconds. One Tasmanian generating unit ramped down below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, some slow raise FCAS was delivered by some units providing a negative response as shown in Figure 4. The flow across Basslink was approximately 474 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.74 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

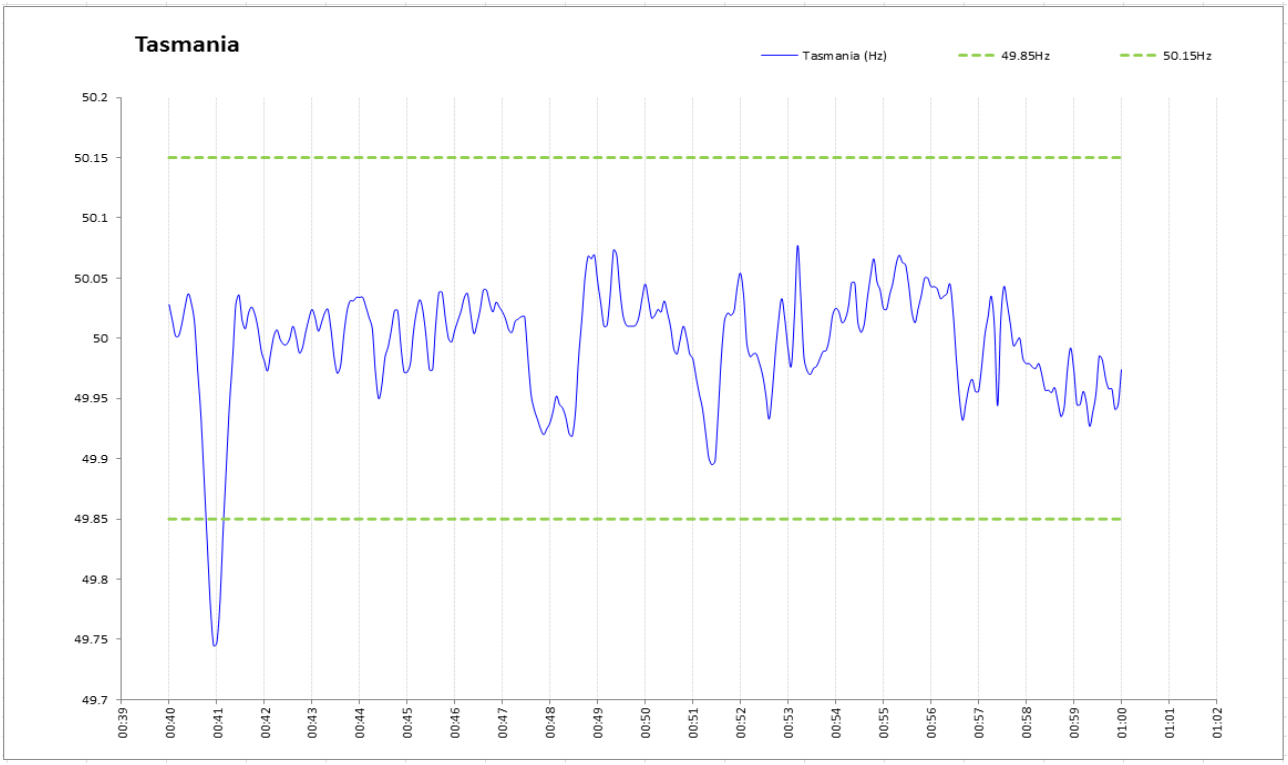

Figure 3: Low Frequency Normal Event in Tasmania refer to item 2 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

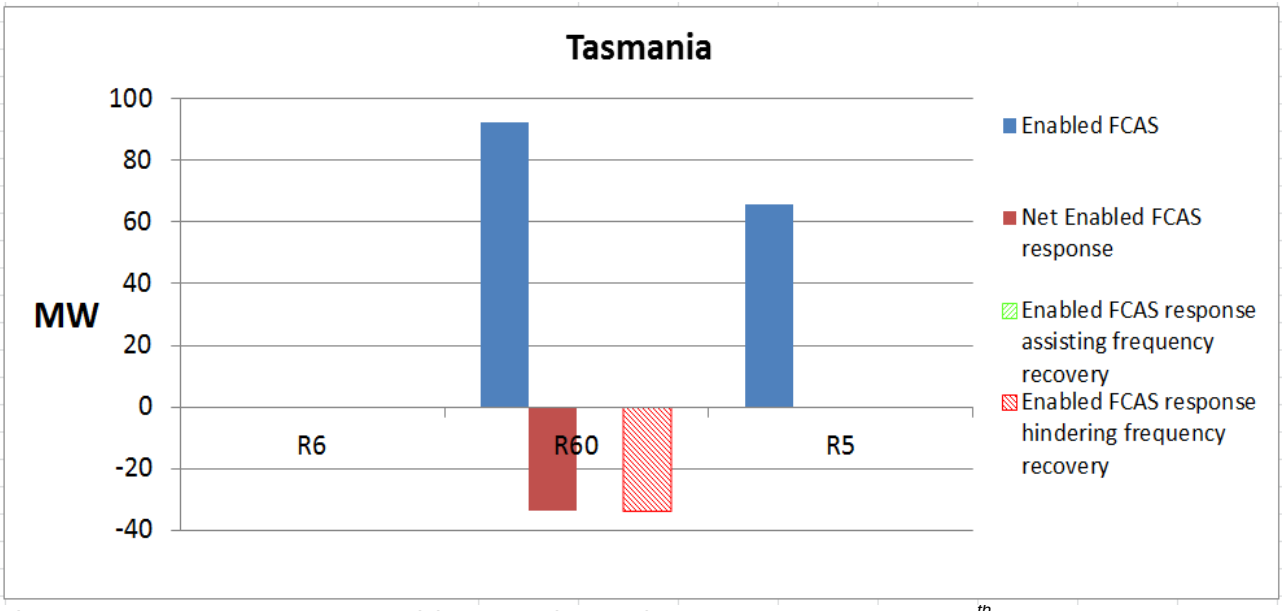

Figure 4: FCAS response to Normal (Non-Contingency) Low Frequency Event on 7th Jan 2012.

4.2.3 Event: 10/01/2012 20:10:20

For the Normal (Non-Contingency) low frequency event on 10th Jan 2012 in Tasmania, Figure 5 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 260 seconds. One Tasmanian generating unit ramped down approximately 50 MW below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 6. The flow across Basslink was approximately 477 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.73 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

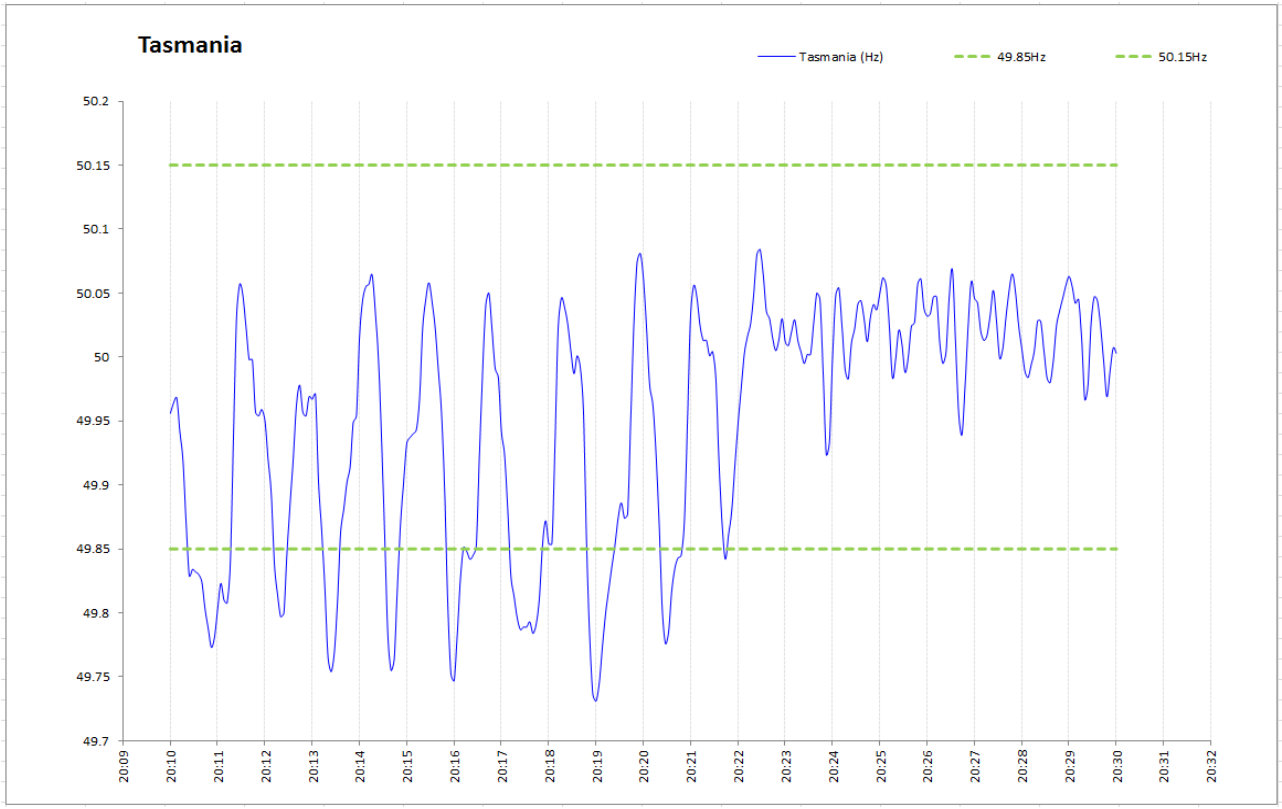

Figure 5: Low Frequency Normal Event in Tasmania refer to item 3 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard

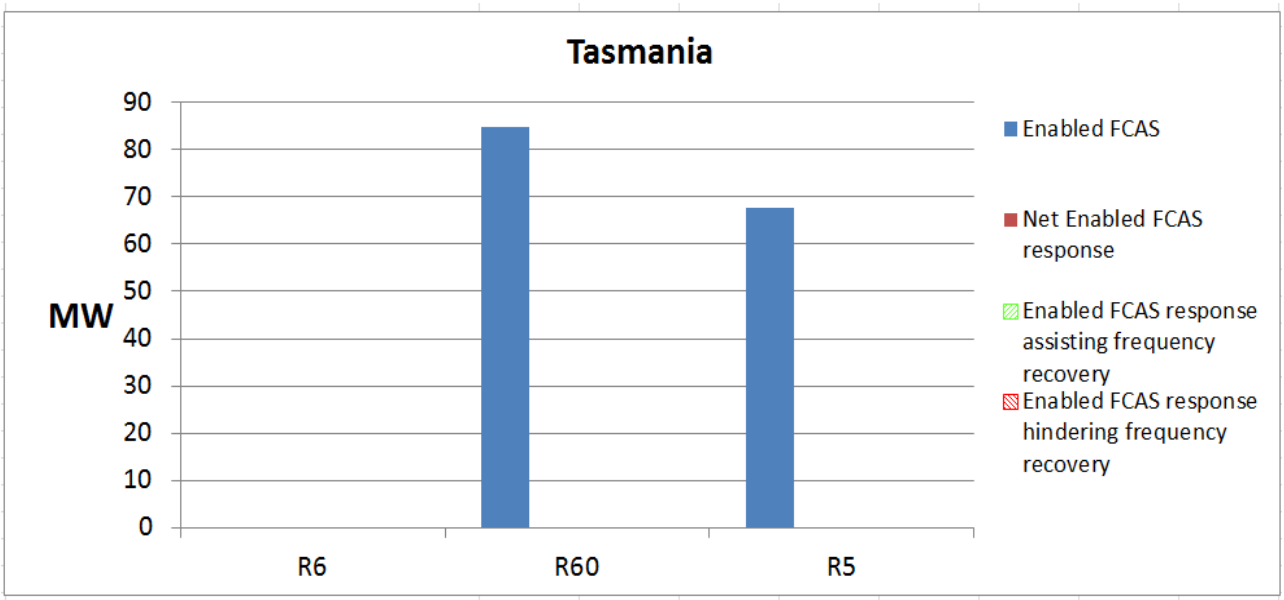

Figure 6: FCAS response to Normal (Non-Contingency) Low Frequency Event on 10th Jan 2012.

4.2.4 Event: 13/01/2012 04:16:08

For the Normal (Non-Contingency) low frequency event on 13th Jan 2012 in Tasmania, Figure 7 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 312 seconds. One Tasmanian generating unit ramped down about 50 MW below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 8. The flow across Basslink was approximately 471 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller delivered about 15 MW of additional FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.61 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

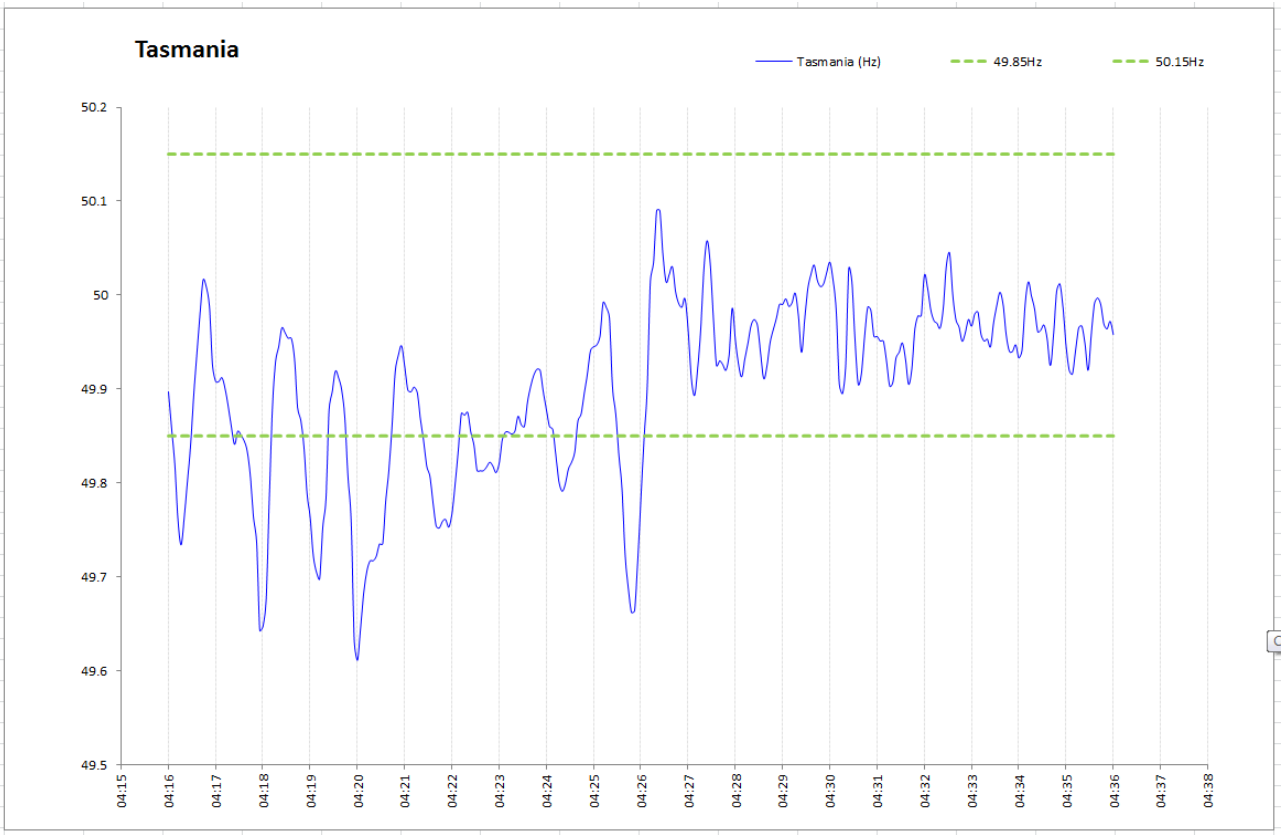

Figure 7: Low Frequency Normal Event in Tasmania refer to item 4 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard

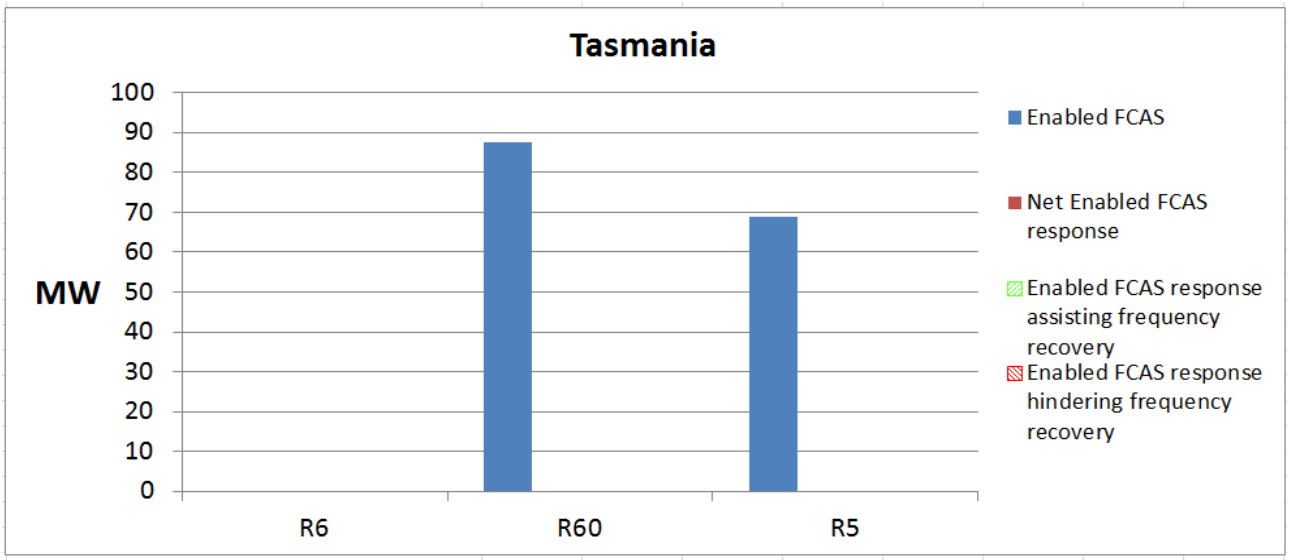

Figure 8: FCAS response to Normal (Non-Contingency) Low Frequency Event on 13th Jan 2012.

4.2.5 Event: 13/01/2012 04:53:36

For the Normal (Non-Contingency) low frequency event on 13th Jan 2012 in Tasmania, Figure 9 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 400 seconds. One Tasmanian generating unit ramped down about 50 MW below its respective generation target, and other two Tasmanian generating units ramped up too slowly to their respective generation targets from start-up which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, about 90% of the slow raise FCAS was delivered as shown in Figure 10. The flow across Basslink was approximately 479 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.52 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

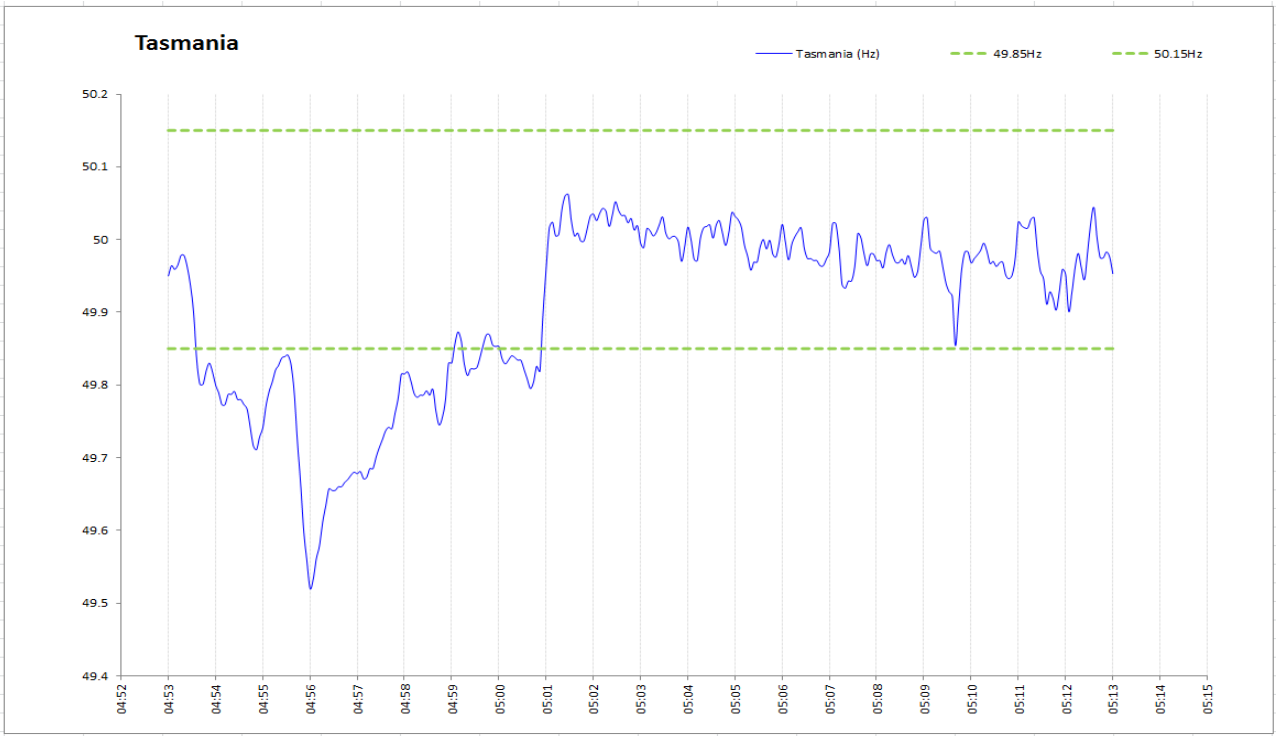

Figure 9: Low Frequency Normal Event in Tasmania refer to item 5 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

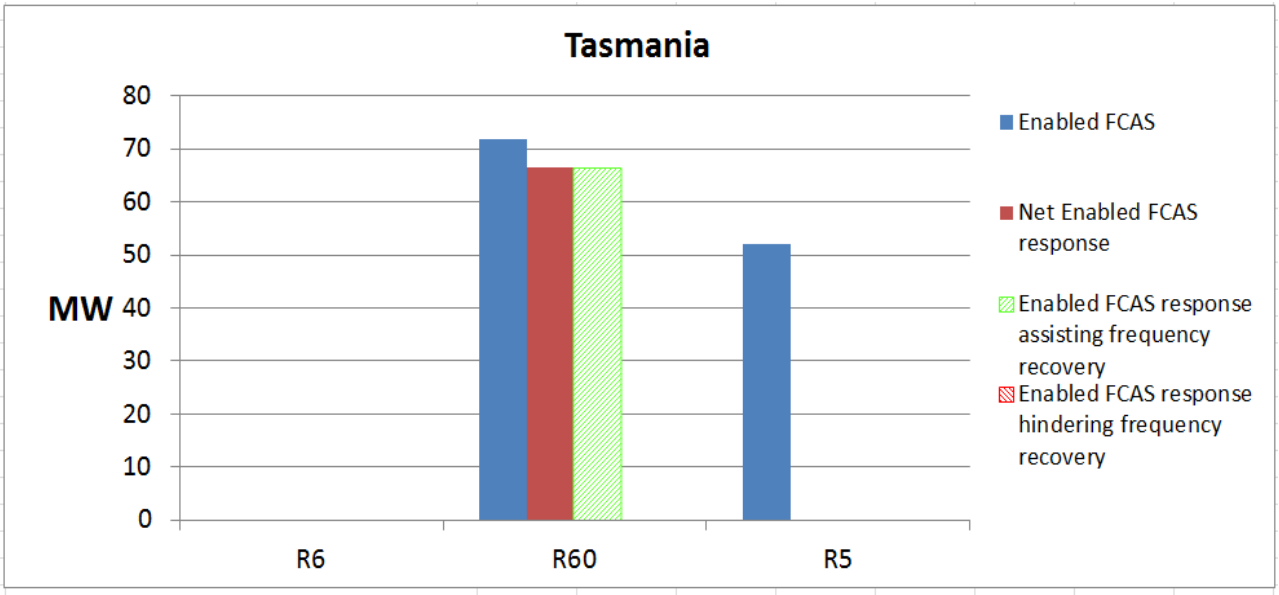

Figure 10: FCAS response to Normal (Non-Contingency) Low Frequency Event on 13th Jan 2012.

4.2.6 Event: 13/01/2012 18:37:08

For the Normal (Non-Contingency) low frequency event on 13th Jan 2012 in Tasmania, Figure 11 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 620 seconds. Two Tasmanian generating units ramped up too slowly to their respective generation targets from start-up which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 12. The flow across Basslink was approximately 470 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.59 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

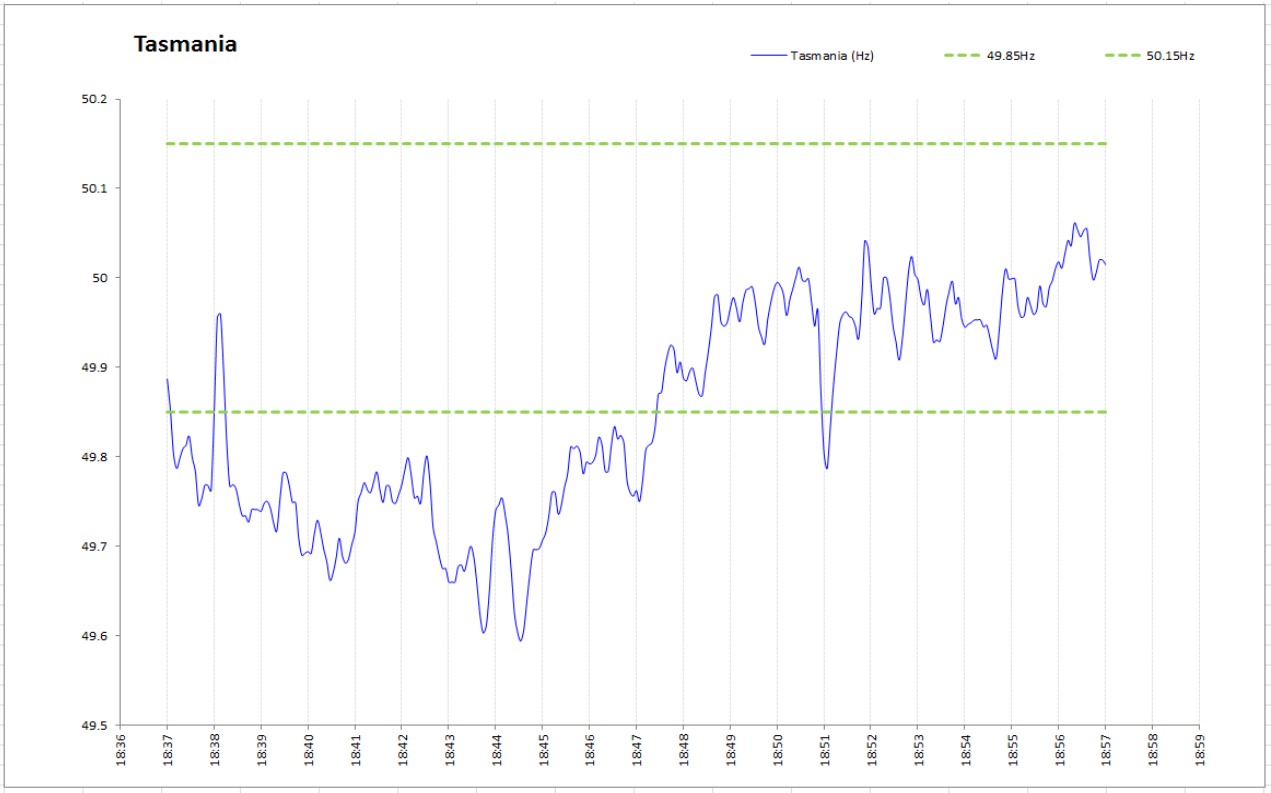

Figure 11: Low Frequency Normal Event in Tasmania refer to item 6 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

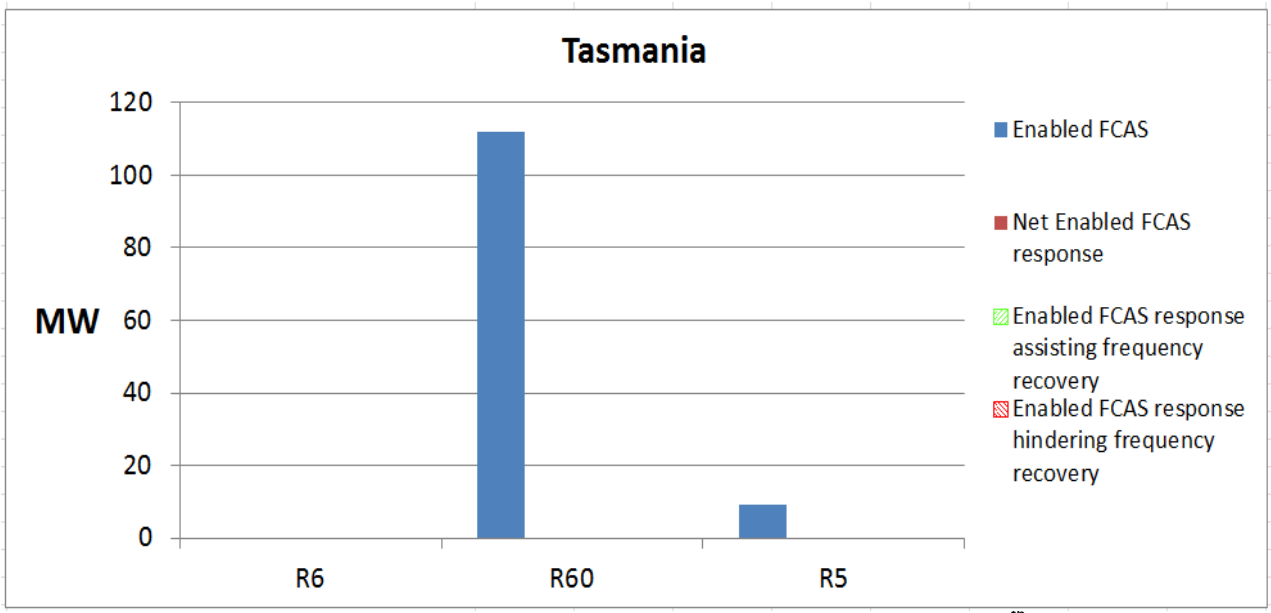

Figure 12: FCAS response to Normal (Non-Contingency) Low Frequency Event on 13tn Jan 2012.

4.2.7 Event: 13/01/2012 22:09:00

For the Normal (Non-Contingency) low frequency event on 13th Jan 2012 in Tasmania, Figure 13 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 96 seconds. One Tasmanian generating unit ramped down from 10 MW to zero MW following its respective generation target, and one Tasmanian generating unit ramped up too slowly to their respective generation targets, which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 14. The flow across Basslink was approximately 473 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.62 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

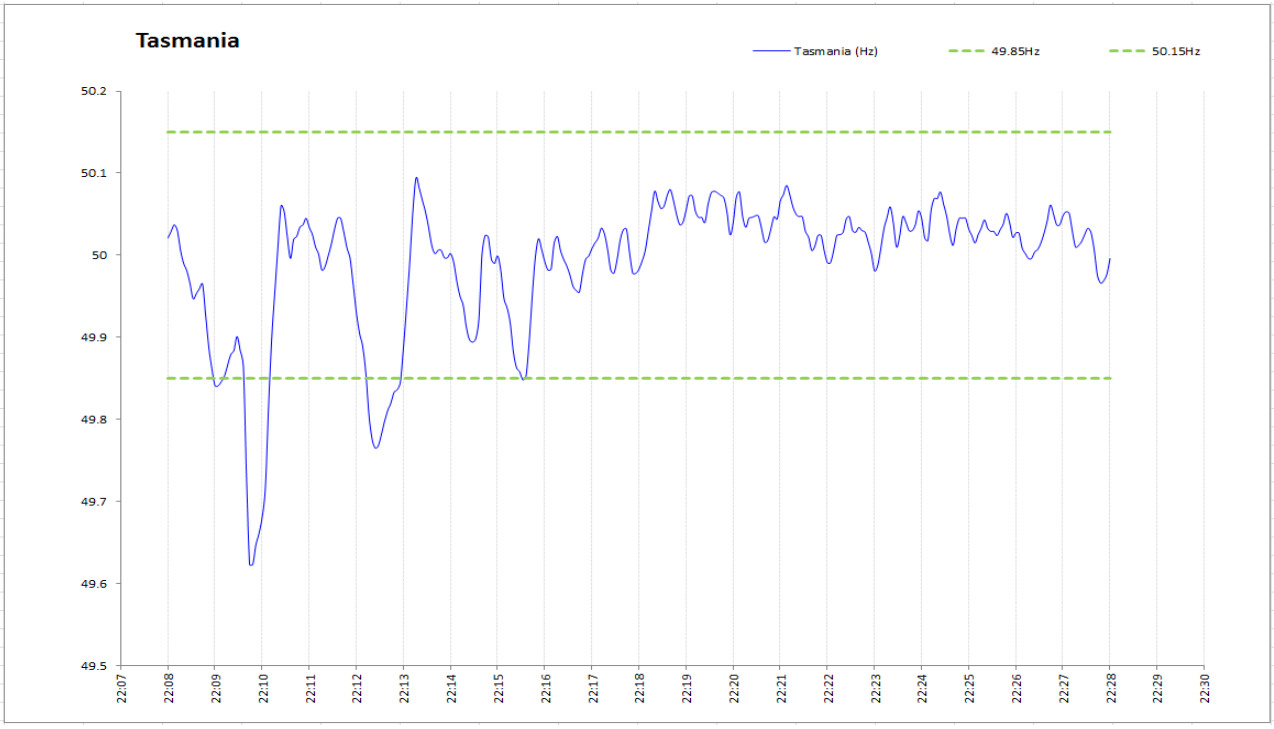

Figure 13: Low Frequency Normal Event in Tasmania refer to item 7 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

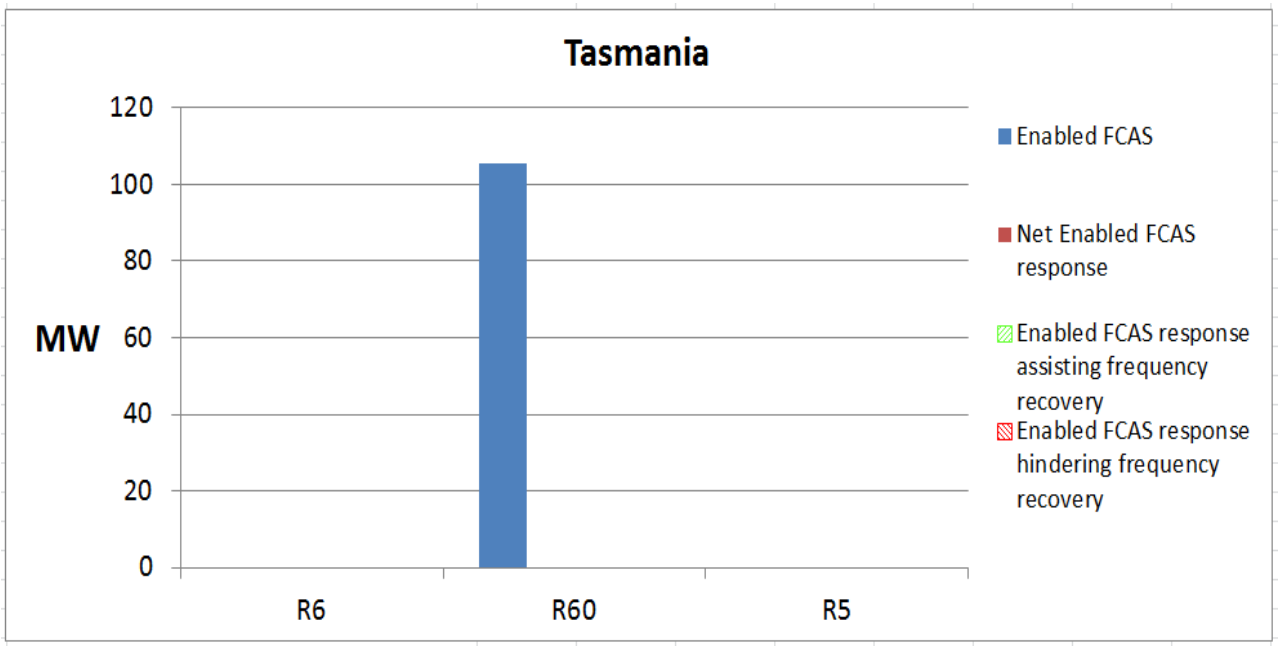

Figure 14: FCAS response to Normal (Non-Contingency) Low Frequency Event on 13th Jan 2012.

4.2.8 Event: 14/01/2012 21:27:56

For the Normal (Non-Contingency) low frequency event on 14th Jan 2012 in Tasmania, Figure 15 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 40 seconds. One Tasmanian generating unit ramped down below its respective generation targets which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, some slow raise FCAS was delivered by some units providing a negative response as shown in Figure 16. The flow across Basslink was approximately 471 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.68 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

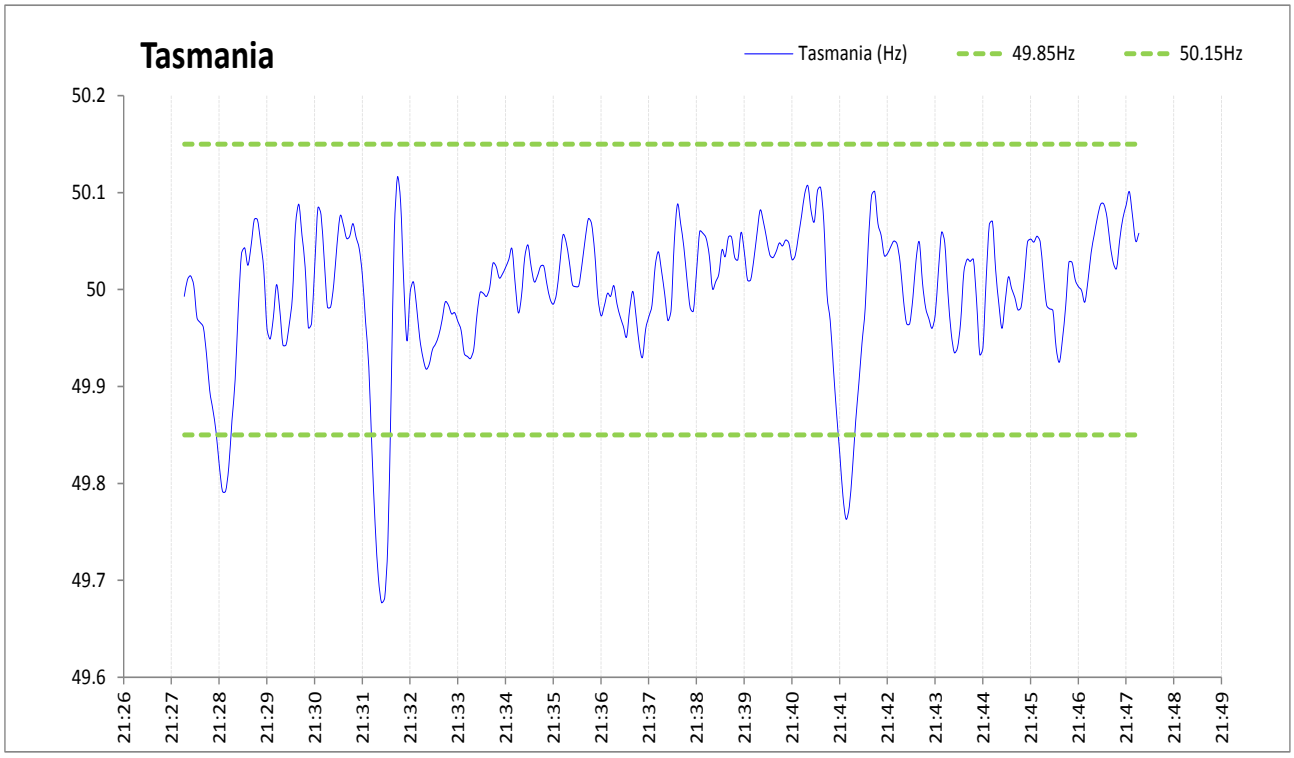

Figure 15: Low Frequency Normal Event in Tasmania refer to item 8 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

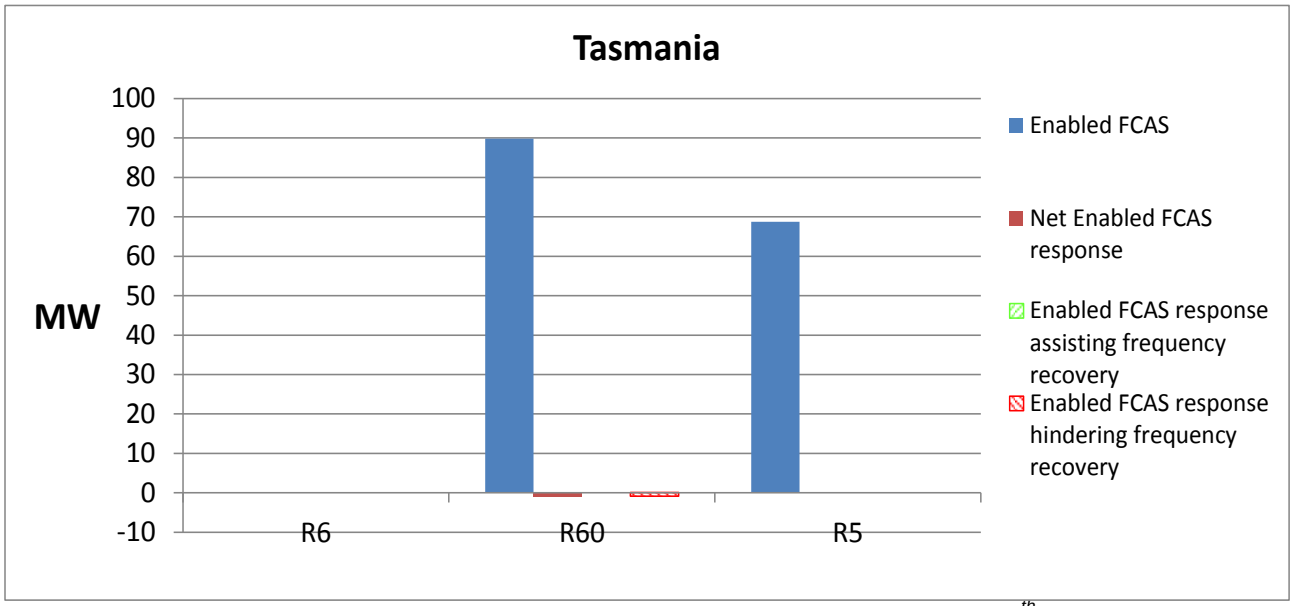

Figure 16: FCAS response to Normal (Non-Contingency) Low Frequency Event on 14th Jan 2012.

4.2.9 Event: 20/01/2012 19:56:28

For the Normal (Non-Contingency) low frequency event on 20th Jan 2012 in Tasmania, Figure 17 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 96 seconds. One Tasmanian generating unit ramped down below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 18. The flow across Basslink was approximately 469 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.68 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

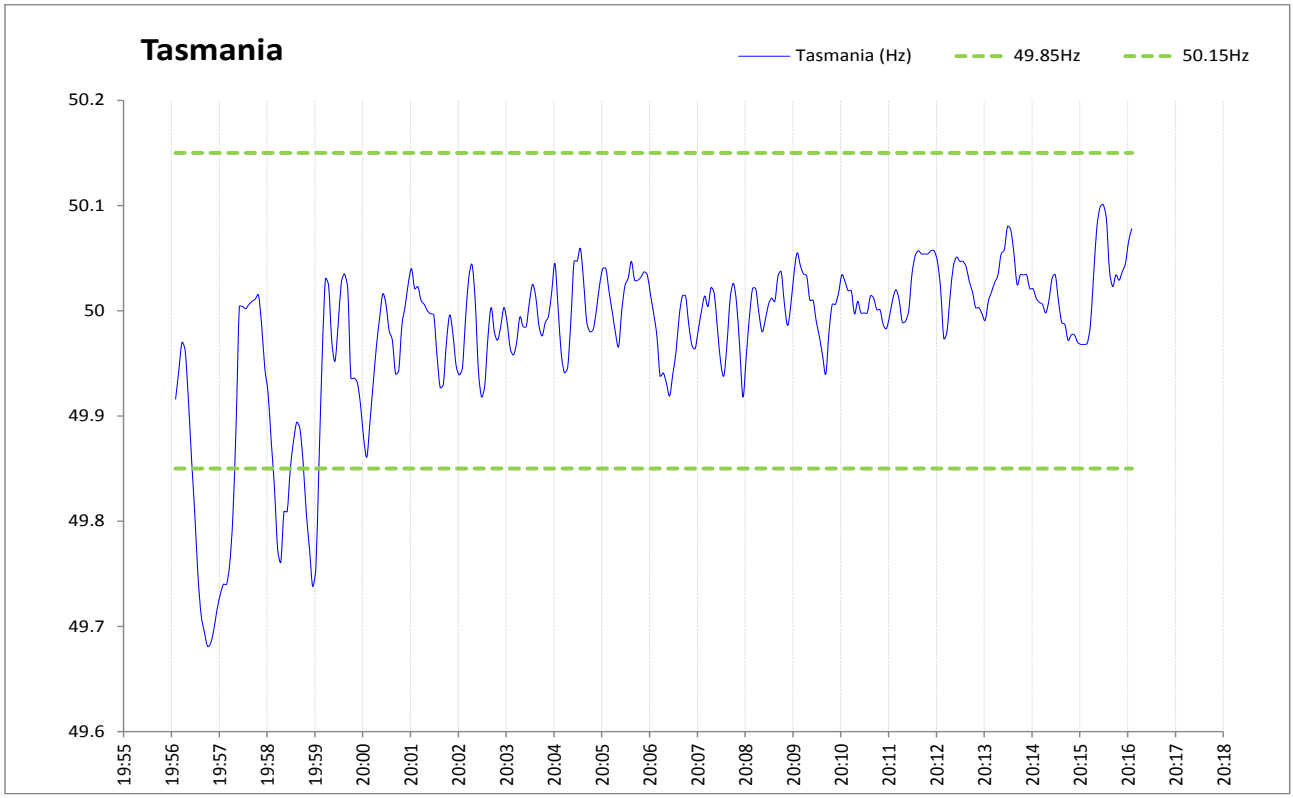

Figure 17: Low Frequency Normal Event in Tasmania refer to item 9 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

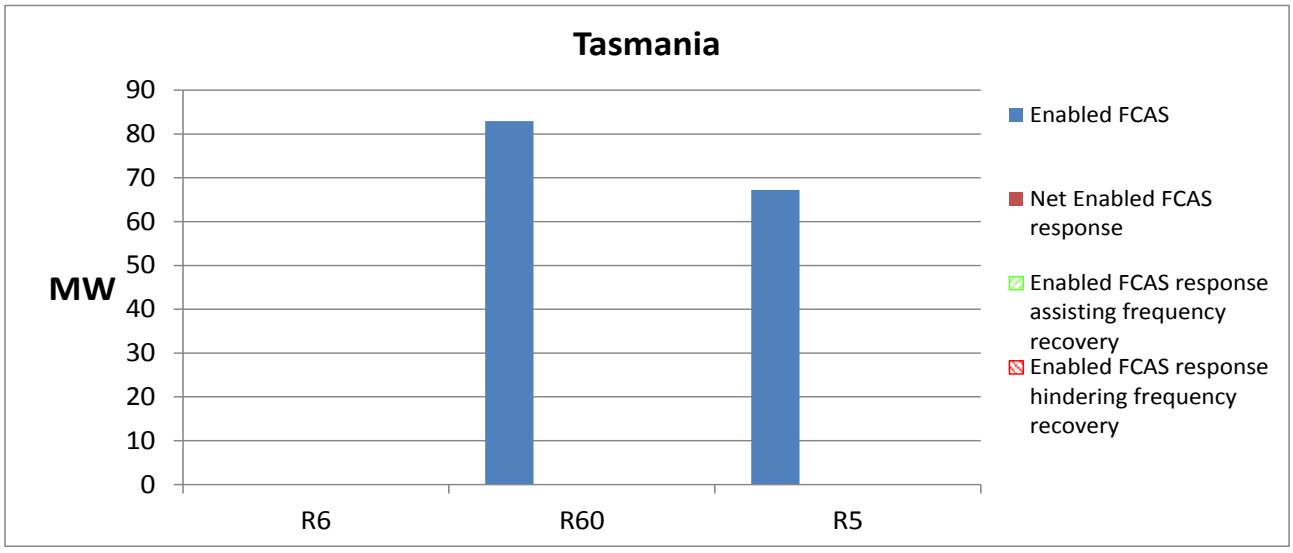

Figure 18: FCAS response to Normal (Non-Contingency) Low Frequency Event on 20th Jan 2012.

4.2.10 Event: 24/01/2012 03:53:20

For the Normal (Non-Contingency) low frequency event on 24th Jan 2012 in Tasmania, Figure 19 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 136 seconds. One Tasmanian generating unit ramped up too slowly to their respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 20. The flow across Basslink was approximately 477 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.69 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

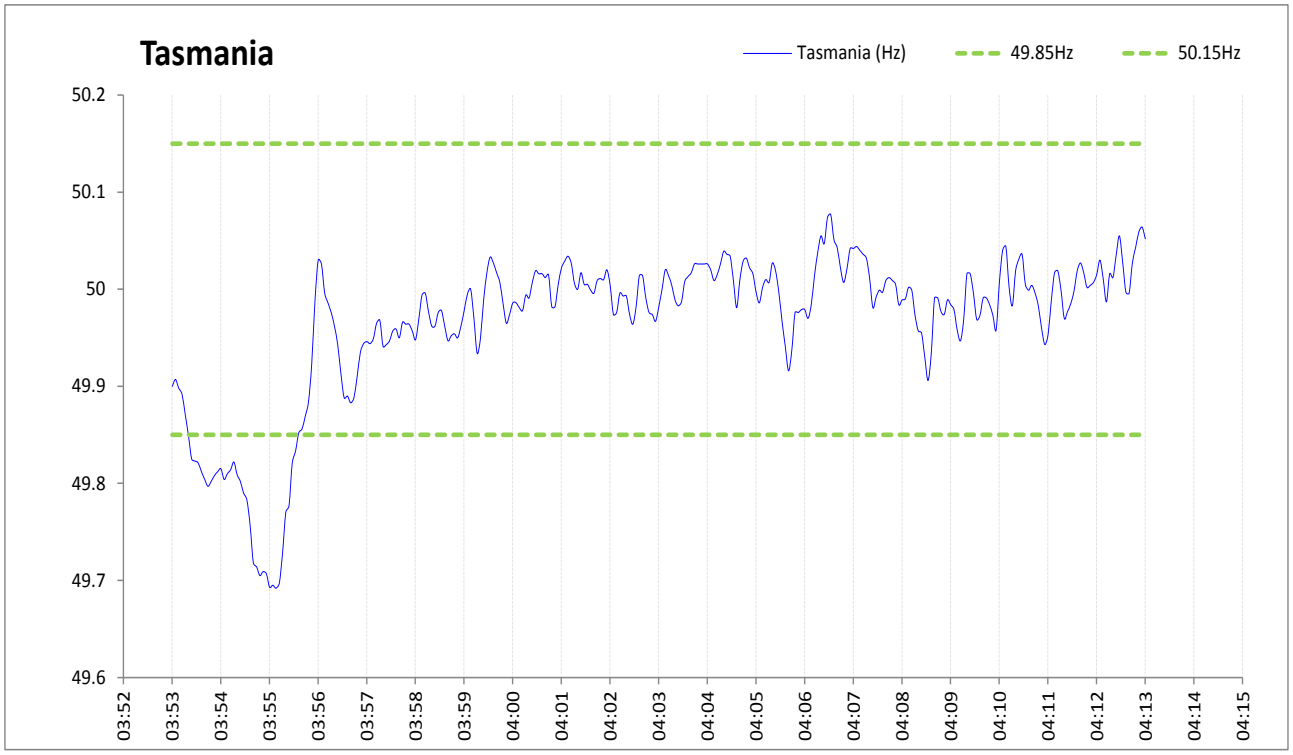

Figure 19: Low Frequency Normal Event in Tasmania refer to item 11 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

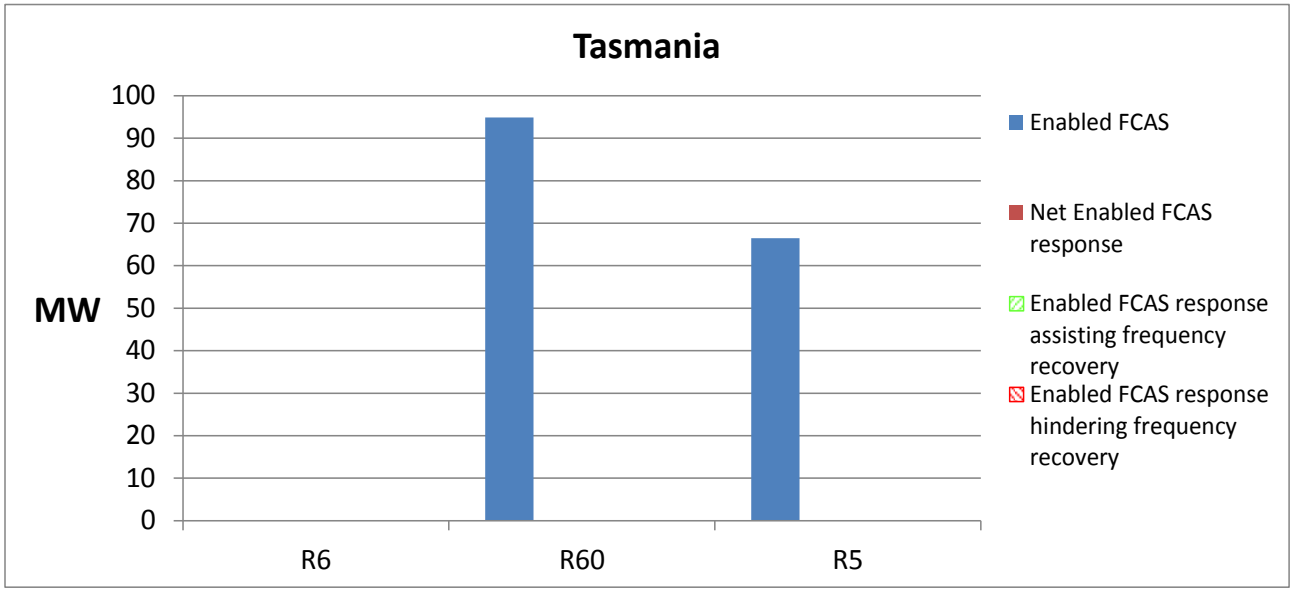

Figure 20: FCAS response to Normal (Non-Contingency) Low Frequency Event on 2th Jan 2012.

4.2.11 Event: 27/01/2012 06:58:16

For the Normal (Non-Contingency) low frequency event on 27th Jan 2012 in Tasmania, Figure 21 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 100 seconds. One Tasmanian generating unit ramped down below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow FCAS, an amount of only about 70% was delivered as shown in Figure 21. The flow across Basslink was approximately 470 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.64 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

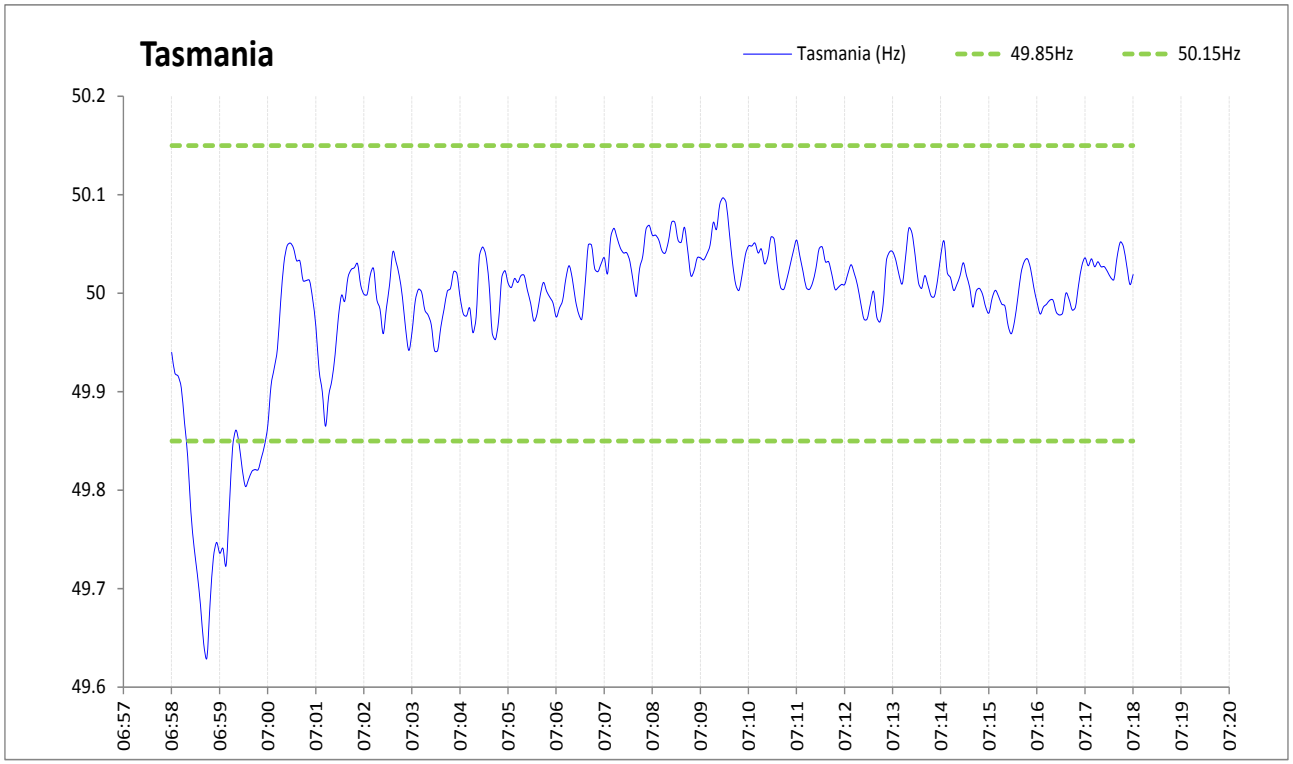

Figure 21: Low Frequency Normal Event in Tasmania refer to item 12 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

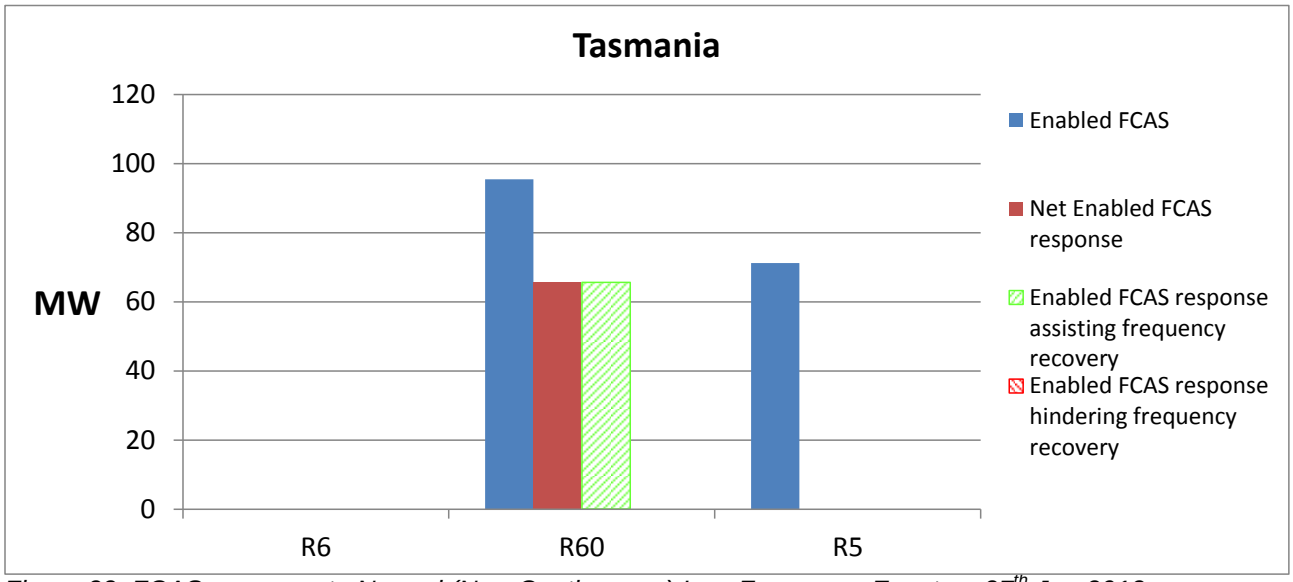

Figure 22: FCAS response to Normal (Non-Contingency) Low Frequency Event on 27th Jan 2012.

4.2.12 Event: 27/01/2012 19:37:56

For the Normal (Non-Contingency) low frequency event on 27th Jan 2012 in Tasmania, Figure 23 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 20 seconds. One Tasmanian generating unit ramped down below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 24. The flow across Basslink was approximately 471 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.67 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

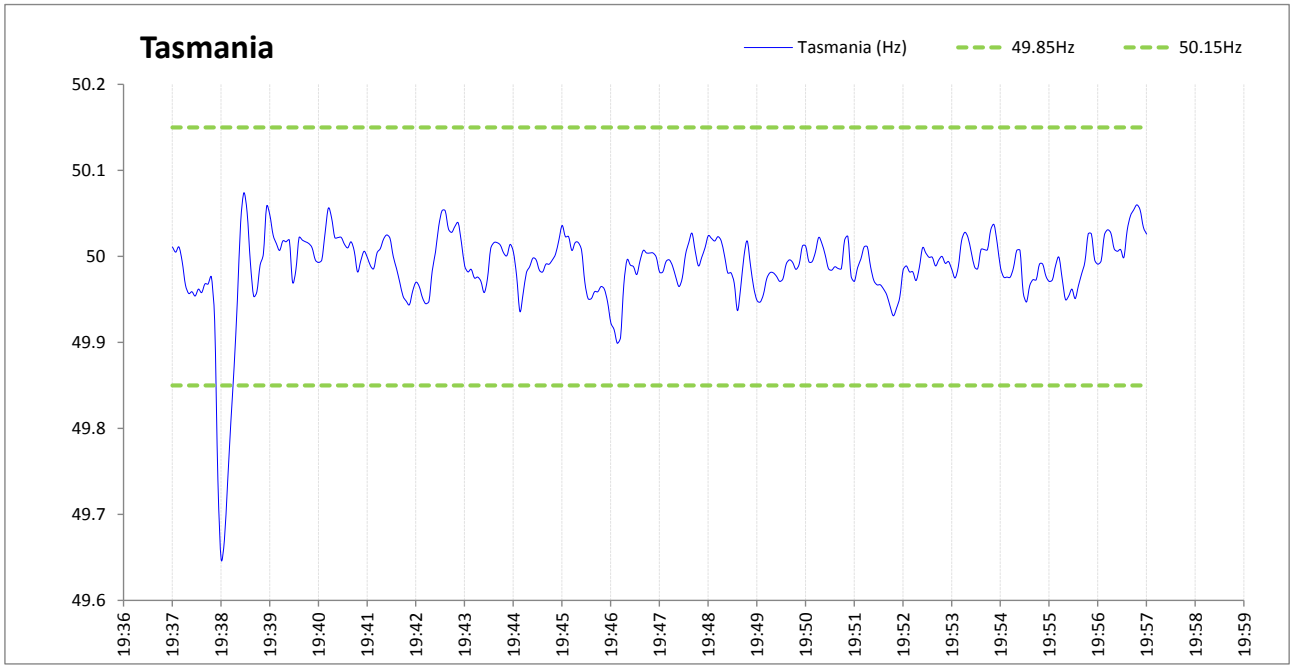

Figure 23: Low Frequency Normal Event in Tasmania refer to item 13 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

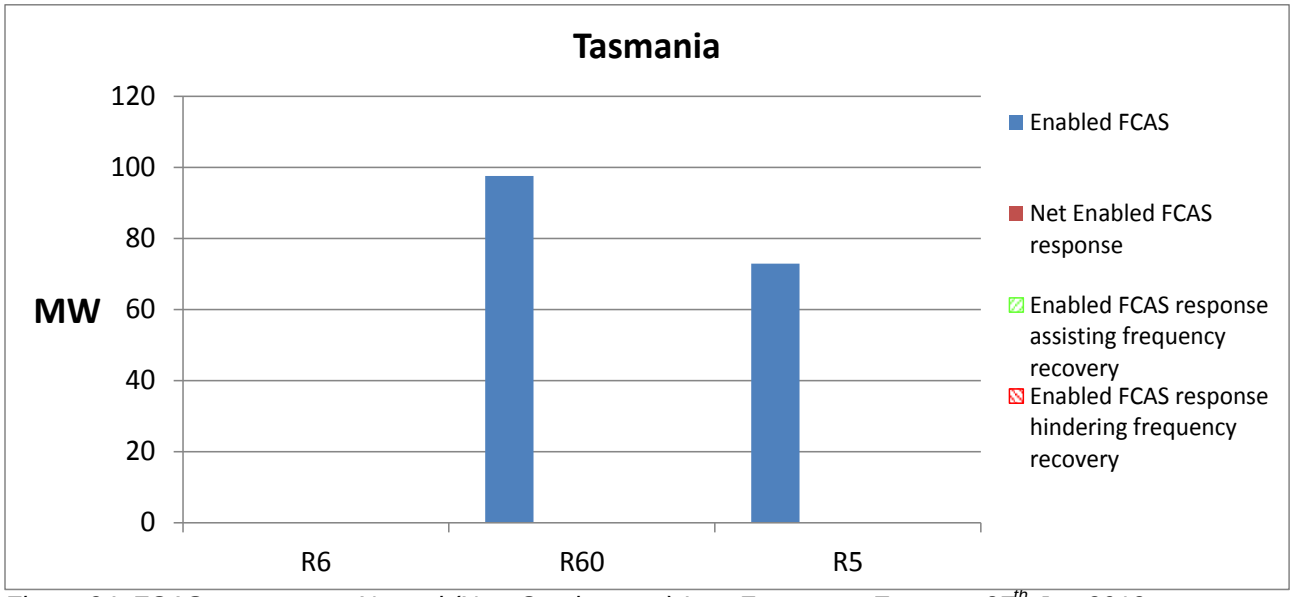

Figure 24: FCAS response to Normal (Non-Contingency) Low Frequency Event on 27th Jan 2012.

4.2.13 Event: 30/01/2012 02:15:00

For the Normal (Non-Contingency) low frequency event on 30th Jan 2012 in Tasmania, Figure 25 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 28 seconds. One Tasmanian generating unit ramped down below its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise FCAS, a zero amount was delivered as shown in Figure 26. The flow across Basslink was approximately 430 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency fell to a minimum of 49.75 Hz in the Tasmania region. The amount of Fast Raise services delivered was not calculated since 50 ms data was not requested for this event.

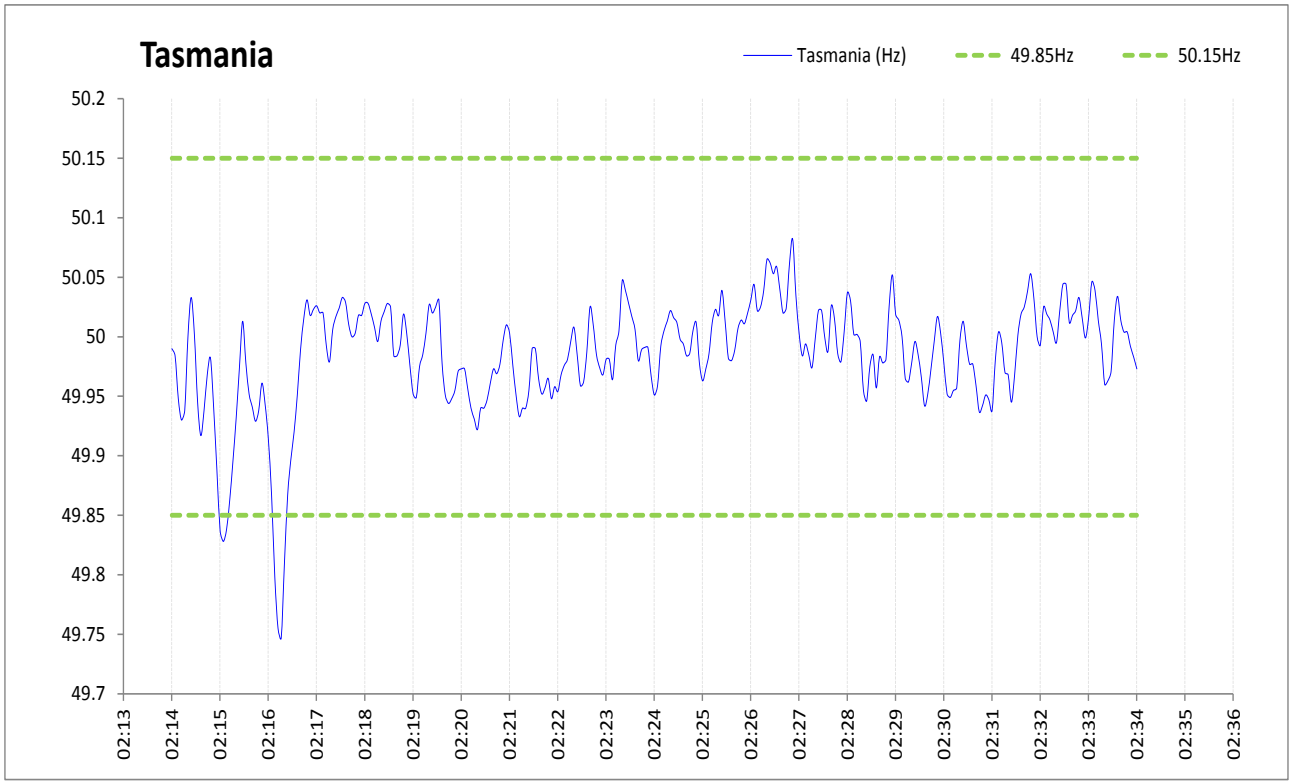

Figure 25: Low Frequency Normal Event in Tasmania refer to item 14 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.

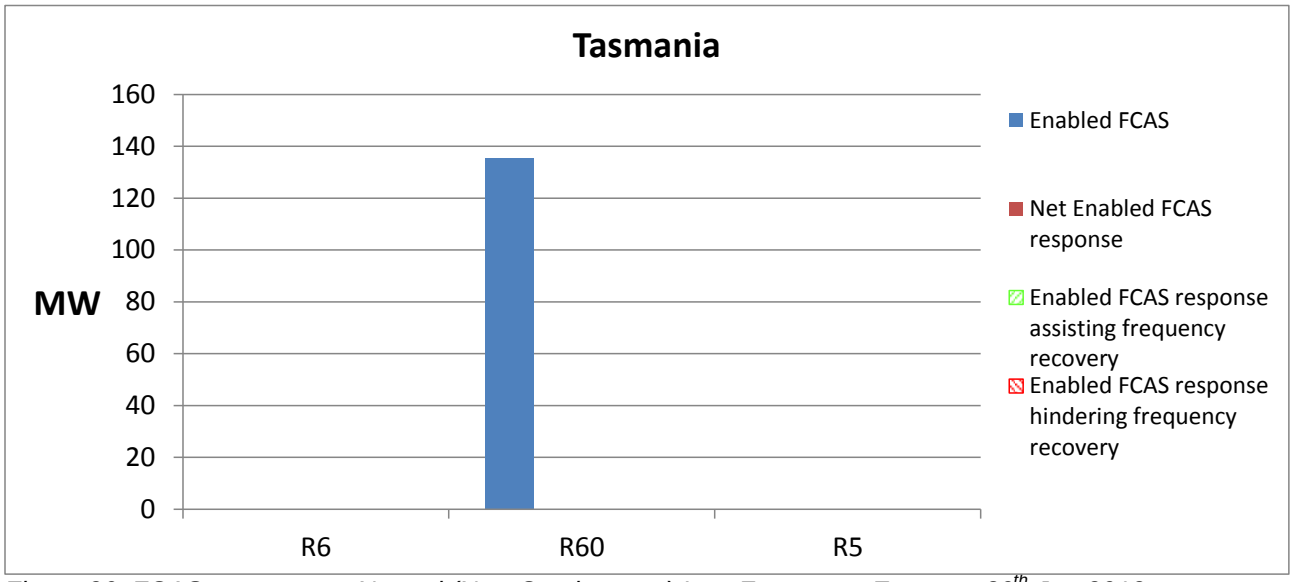

Figure 26: FCAS response to Normal (Non-Contingency) Low Frequency Event on 30th Jan 2012.

4.3 Low and High Frequency Event in Tasmania

Table 3: Low and High Frequency Normal Events in the Tasmania region resulting in frequency outside the Tasmania Frequency Operating Standards.

DATE	EVENTS	MIN FREQUENCY (HZ)	MIN FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)
22/01/2012 19:08:52	No condition causing the event was identified.	49.68	50.53	40

4.3.1 Event: 22/01/2012 19:08:52

For the Normal (Non-Contingency) low and high frequency event on 22nd Jan 2012 in Tasmania, Figure 27 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 68 seconds. The sudden increase in Tasmanian total load demand by 10 MW ~ 20 MW increments contributed to the low frequency excursion although Tasmanian generation also increased in response to the total demand. Five of the Tasmanian generating units were generating above their respective generation targets which contributed to the high frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, some slow raise FCAS was delivered by some units providing a negative response as shown in Figure 28. Compared to the enabled slow lower and delayed lower FCAS, a zero amount was delivered as shown in Figure 29. The flow across Basslink was approximately 45 MW towards Victoria during the time of the low and high frequency excursion. Since Basslink cannot transfer FCAS where the provision of the FCAS would cause the Basslink flow to enter the no-go zone, the FCAS transfer from Basslink would have been limited during this time. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. Frequency reached a minimum of 49.68 Hz and maximum of 50.53 Hz in the Tasmania region. The amount of Fast Raise and Fast Lower services delivered was not calculated since 50 ms data was not requested for this event.

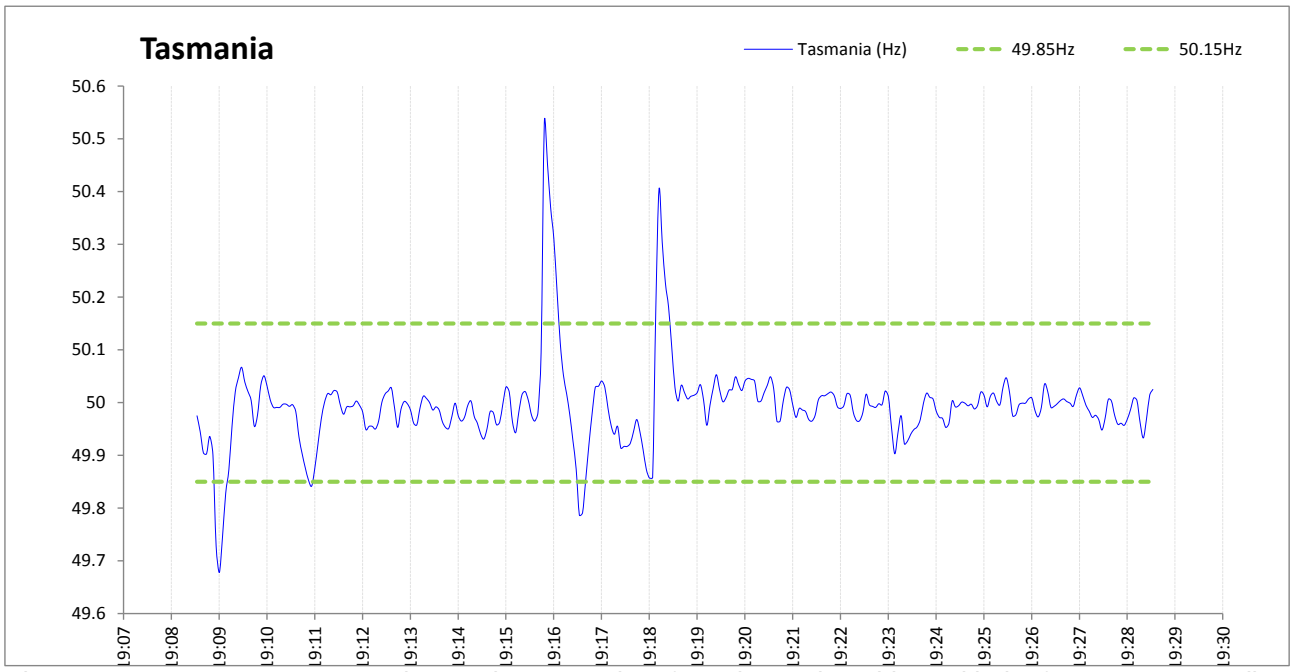

Figure 27: Low Frequency Normal Event in Tasmania refer to item 1 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

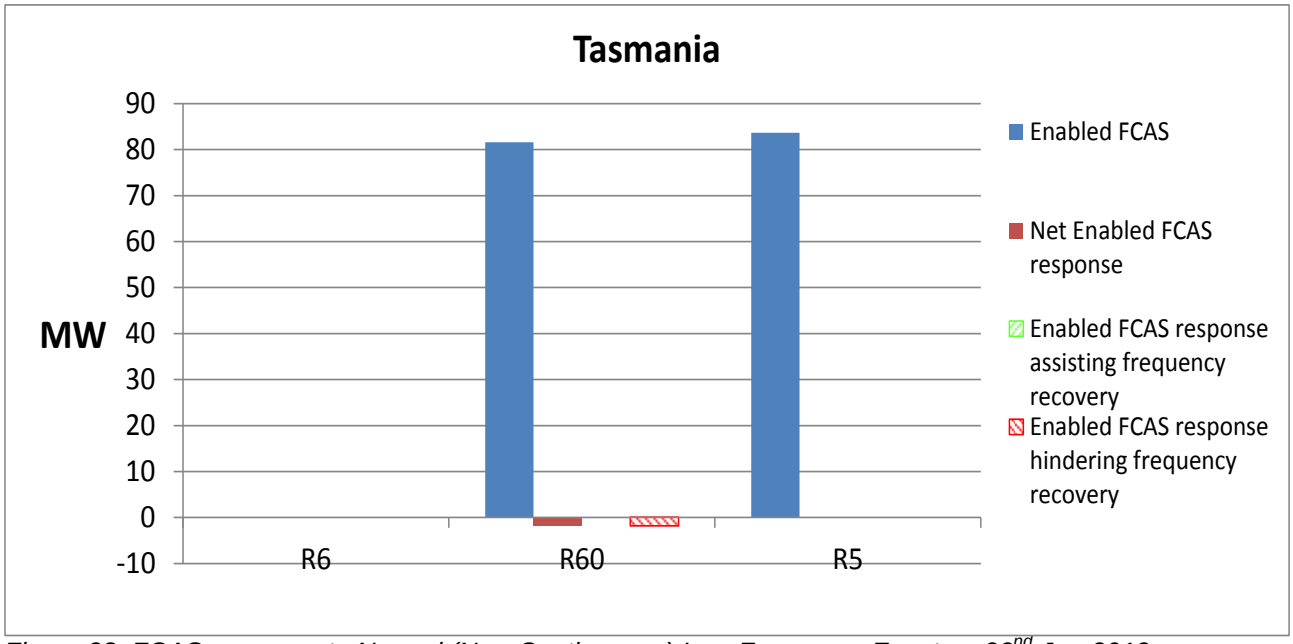

Figure 28: FCAS response to Normal (Non-Contingency) Low Frequency Event on 22nd Jan 2012.

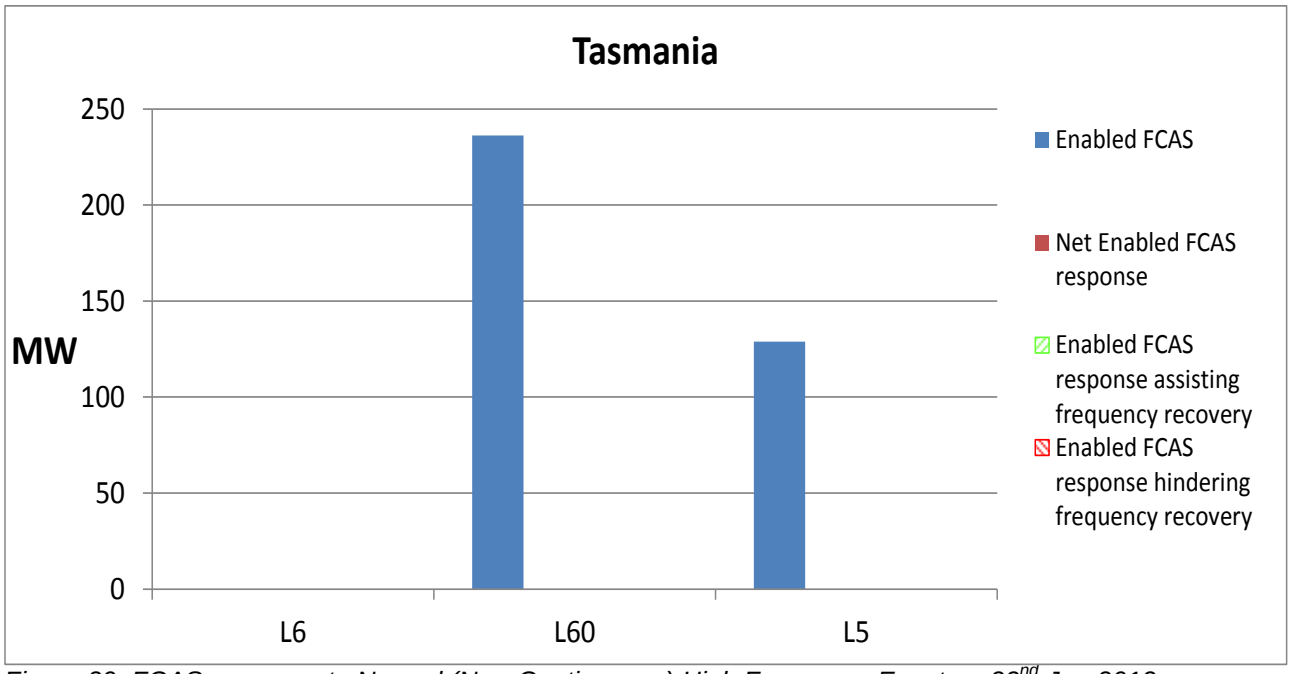

Figure 29: FCAS response to Normal (Non-Contingency) High Frequency Event on 22nd Jan 2012.

5 Statistical Analysis

With exception of load, generation, network, separation and multiple contingency events which are excluded, the frequency distribution for the Mainland and Tasmanian regions were within the frequency operating standards in the month of January 2012.

Frequency in the Mainland regions was within the range 49.92 Hz to 50.07 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 Hz for 100% of the time. The mean value of frequency during January 2012 was 50 Hz with a standard deviation of 0.028 Hz.

Frequency in the Tasmania region was within the range 49.90 Hz to 50.09 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 Hz for 99.97 % of the time. The mean value of frequency during January 2012 was 50 Hz with a standard deviation of 0.040 Hz.

5.1.1 Daily Frequency Standard Deviation

Figure 30 and Figure 31 below plot the daily standard deviation of the Mainland and Tasmanian frequency for the past 13 months, and do not exclude load and contingency events.

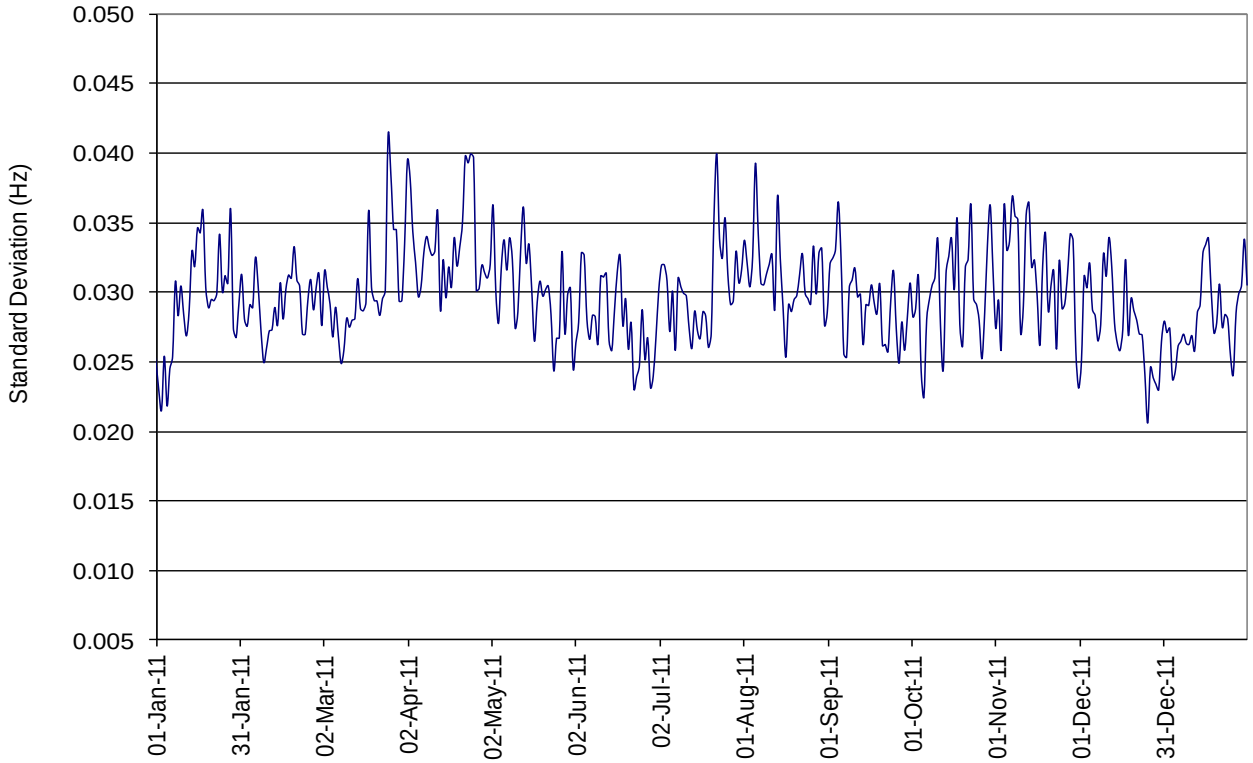

Figure 30: Daily standard deviation of Mainland frequency.

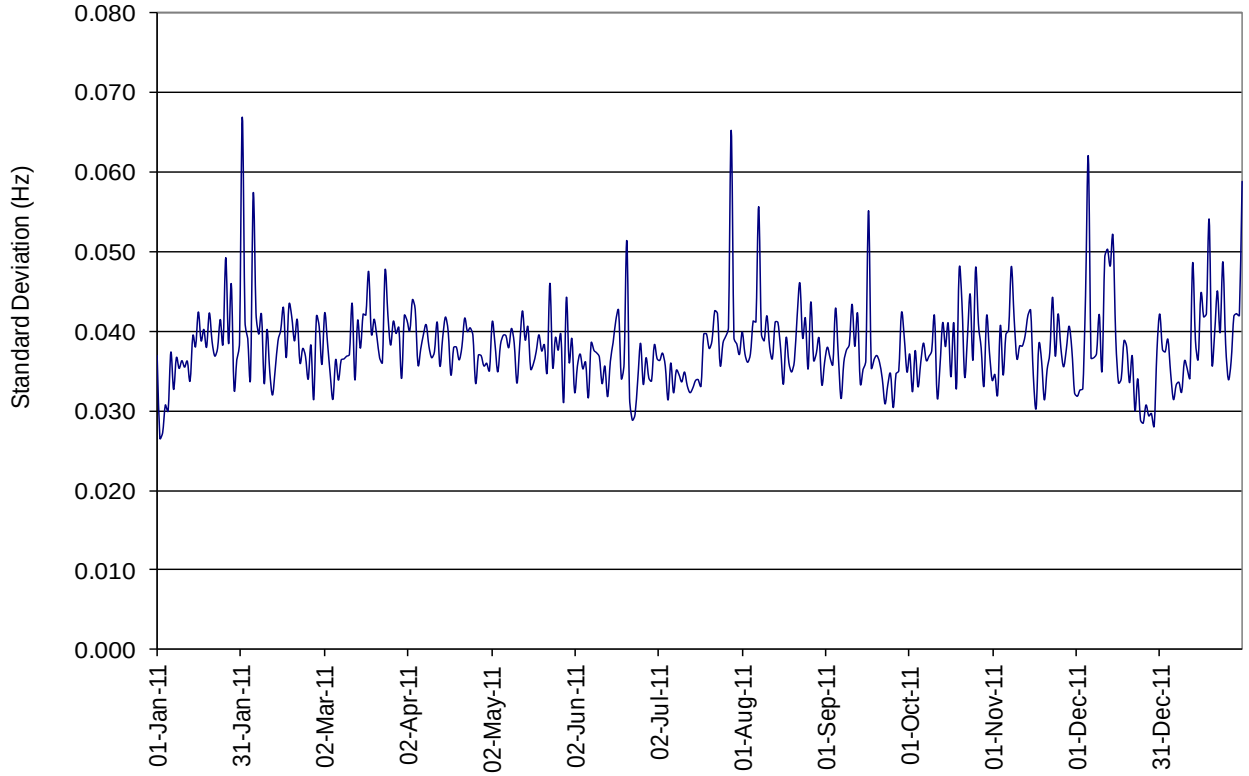

Figure 31: Daily standard deviation of frequency in Tasmania.

5.1.2 Time of day Analysis

This section details the standard deviation of system frequency on a monthly and daily basis. Figure 32 and Figure 33 show the average half-hourly standard deviation of the Mainland regions and Tasmania frequency for November 2011, December 2011 and January 2012. The effects of contingency events have not been filtered from this time of day analysis.

The theoretical limit of 0.049 Hz shown in Figure 32 and Figure 33 would ensure that 99% of observed values were in the range 49.85 - 50.15 Hz with a very small probability of being less than 49.75 Hz and greater than 50.25 Hz. (This assumes that the frequency distribution follows an ideal normal distribution).

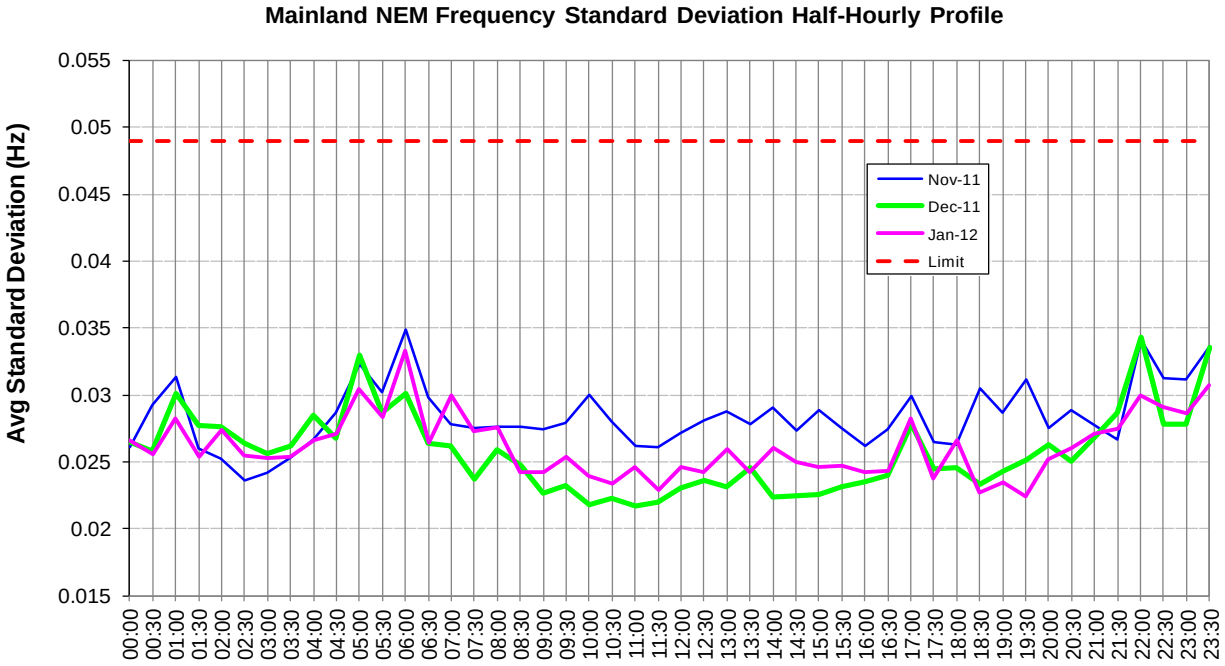

Figure 32: Daily profile of standard deviation for the frequency in the Mainland regions.

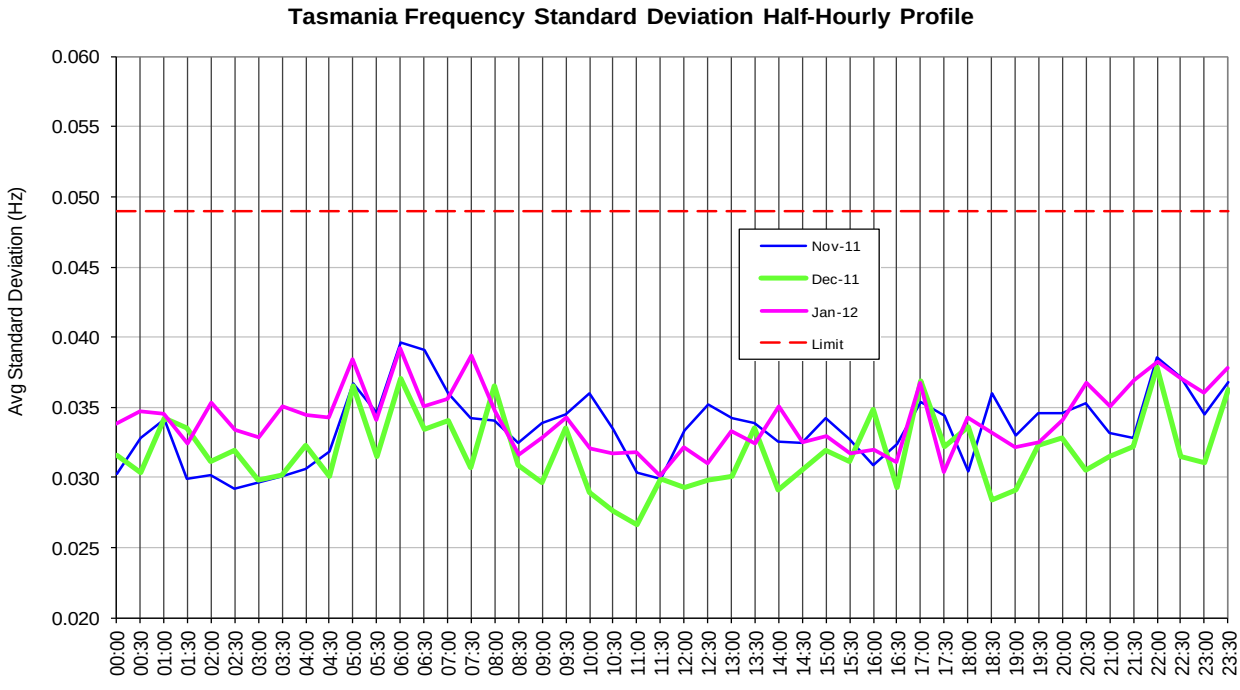

Figure 33: Daily profile of standard deviation for the frequency in Tasmania.

6 Accumulated Time Deviation

The frequency operating standards require that the accumulated time deviation be maintained within the range ± 5 seconds in Mainland regions and ± 15 seconds in Tasmania.

For a separation event there is no requirement in the frequency operating standards that time deviation be maintained within the ranges specified above.

The range of accumulated time deviations recorded throughout the NEM during January 2012 is provided in Table 4.

Table 4: Accumulated time deviation statistics

	QLD	NSW	VIC	SA	TAS
Maximum Positive Deviation (s)	**1.88**	**2.07**	**1.56**	**1.29**	**6.63**
Maximum Negative Deviation (s)	**-3.07**	**-2.86**	**-3.40**	**-3.67**	**-8.57**
Mean Value (s)	**-0.218**	**0.040**	**-0.560**	**-0.807**	**-1.182**
Standard Dev (s)	**0.587**	**0.585**	**0.587**	**0.586**	**2.317**

The distribution of time deviations based on the Mainland regions measurement is provided in Figure 34.

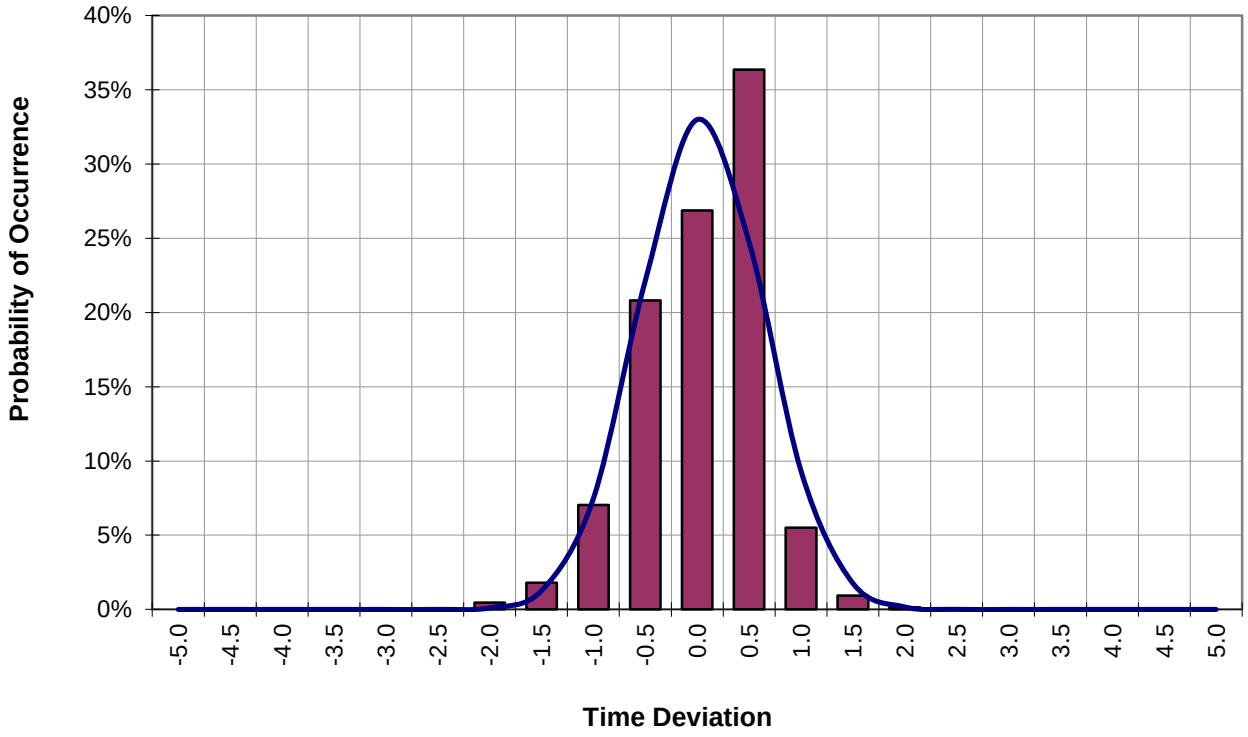

Figure 34: Mainland time deviation distribution for January 2012.

The distribution of time deviations based on the Tasmania region measurement is provided below in Figure 35Figure .

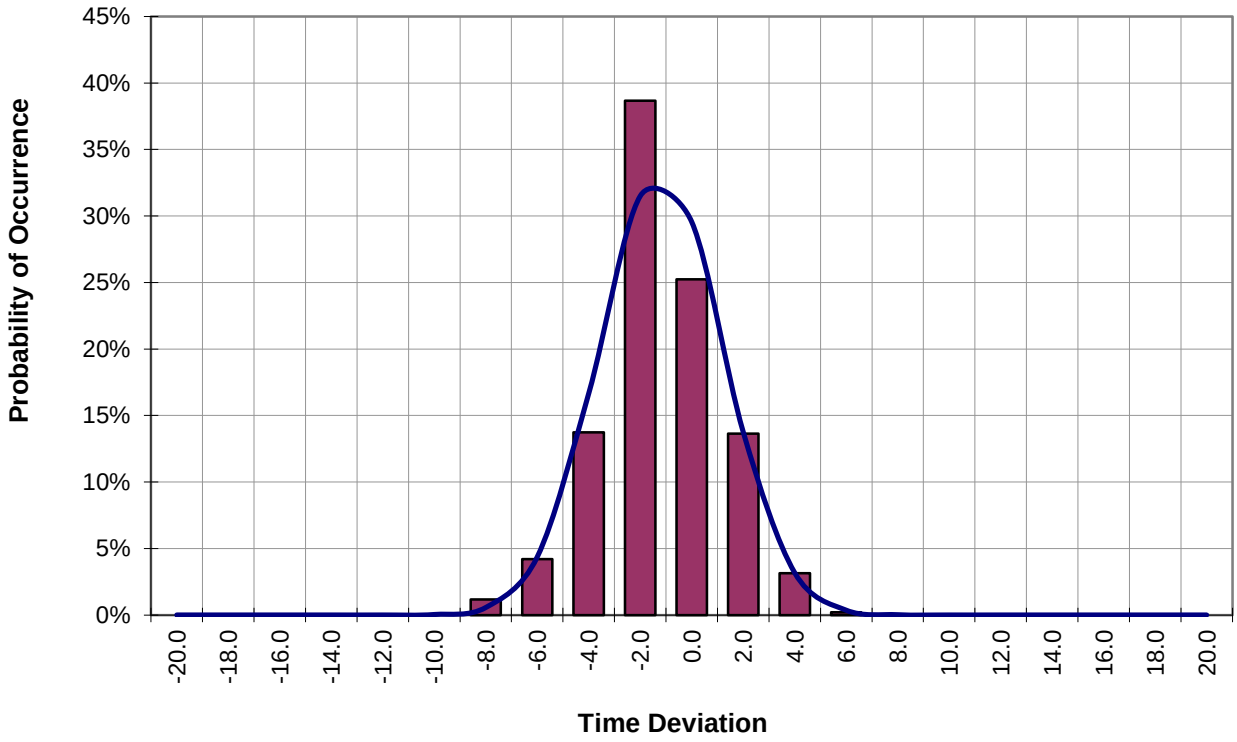

Figure 35 Tasmania time deviation distribution for January 2012.

6.1 Time Error Performance

Figure 36 below presents the daily maximum and minimum values of the Mainland regions time error observed for the past 13 months.

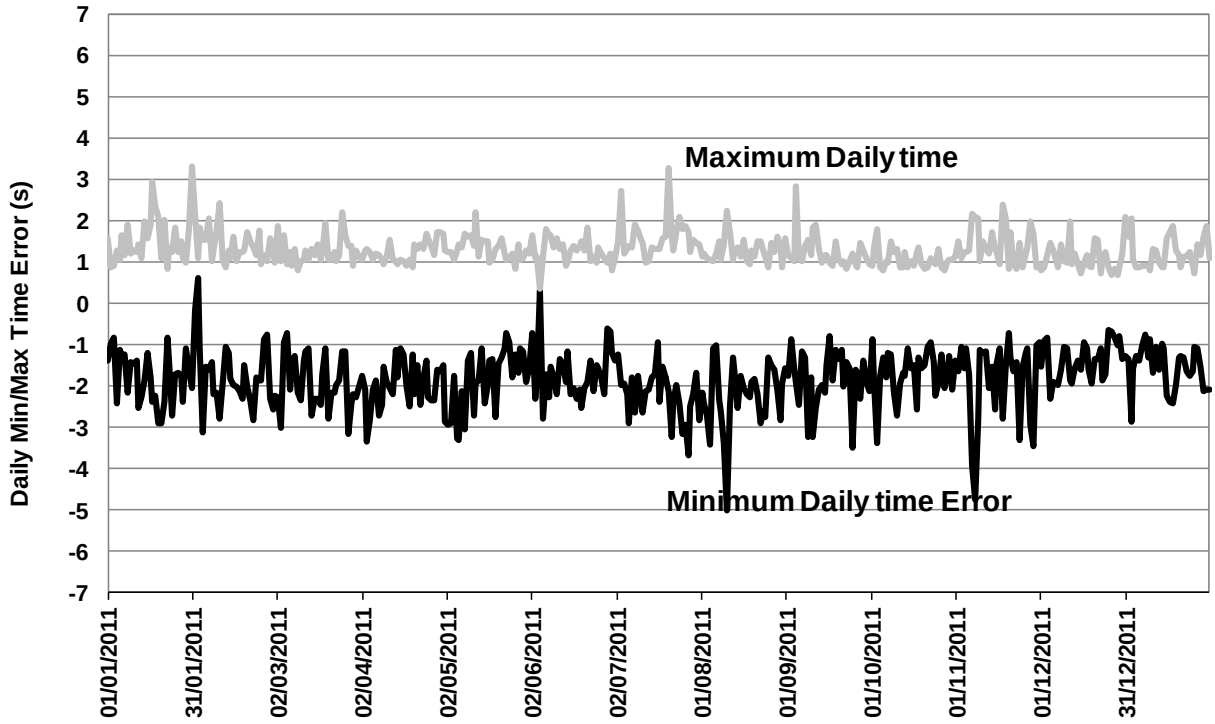

Figure 36: Mainland regions daily maximum and minimum time deviation

Figure 37 below presents the daily maximum and minimum values of Tasmania time error observed for the past 13 months.

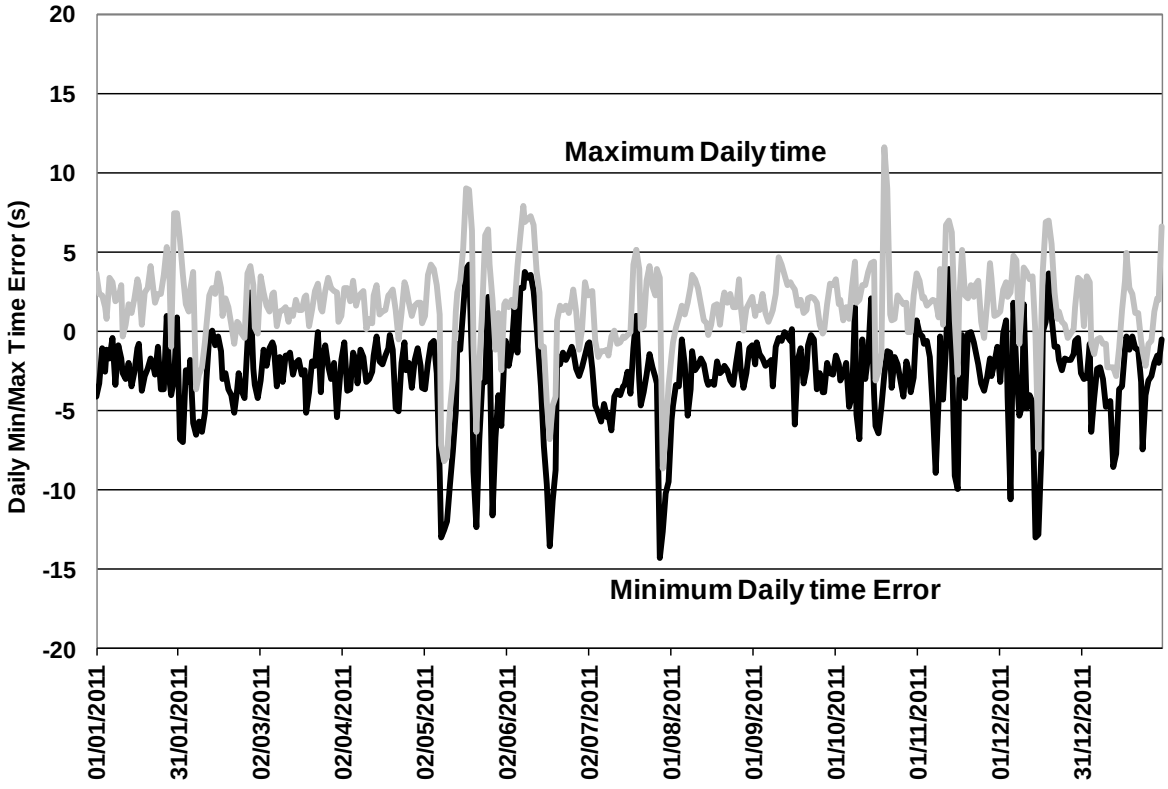

Figure 37: Tasmania daily maximum and minimum time deviation