

POWER SYSTEM FREQUENCY AND TIME DEVIATION MONITORING

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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 May 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 site¹.

The “Power System Frequency and Time Deviation Monitoring Report – Reference Guide²” 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 May 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/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	76
	HIGH	1	26
Load Event	LOW	0	157
	HIGH	0	167
Generation Event	LOW	3	3
	HIGH	0	0
Network Event	LOW	0	0
	HIGH	0	0
Separation Event	LOW	0	0
	HIGH	0	0
Multiple Contingency Event	LOW	0	2
	HIGH	0	1

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 1 as not meeting the frequency operating standard applicable to each event.

4.1 High Frequency Events in Mainland Regions

There was one High Frequency No-Contingency Event from Table 1 recorded in Mainland regions during May 2012 that resulted in frequency above 50.25 Hz. This event listed in Table 2 did not meet the Mainland Frequency operating Standards.

Table 2 : Events in the Mainland region resulting in frequency exceeding the Mainland Frequency operating Standards.

DATE	EVENT	MAX FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)(SECONDS)
23/05/2012 15:24:08	No condition causing the event was identified.	50.48	4

4.1.1 Event: 23/05/2012 15:24:08

For the No-Contingency high frequency event on 23rd May 2012 in Mainland, Figure 1 shows that the Mainland region frequency (measured at NSW frequency) exceeded the Mainland Frequency Operating Standards and was outside the normal operating band for 4 seconds. One NSW generation plant ramped up rapidly by about 37 MW and it was about 88 MW above its generation target which contributed to the Mainland frequency excursion. The flow across Basslink was approximately 110 MW towards Mainland about 10 MW more than its target during the time of the frequency excursion. Basslink frequency controller did not deliver any FCAS from Tasmania during the time of this event. Compared to the enabled slow lower and delayed lower FCAS, a zero amount was delivered as shown in Figure 2. The Mainland frequency excursion stabilized within 2 seconds of time and did not deliver the enabled lower FCAS services as the frequency excursion did not last long enough to trigger switched controllers to deliver slow or delayed FCAS during the event. Frequency rose to a maximum of 50.48 Hz in the Mainland region. The amount of Fast Lower services delivered was not calculated since 50 ms data was not requested for this event. Tasmania frequency was not affected by this No-Contingency event and was operating within the Normal Operating Band.

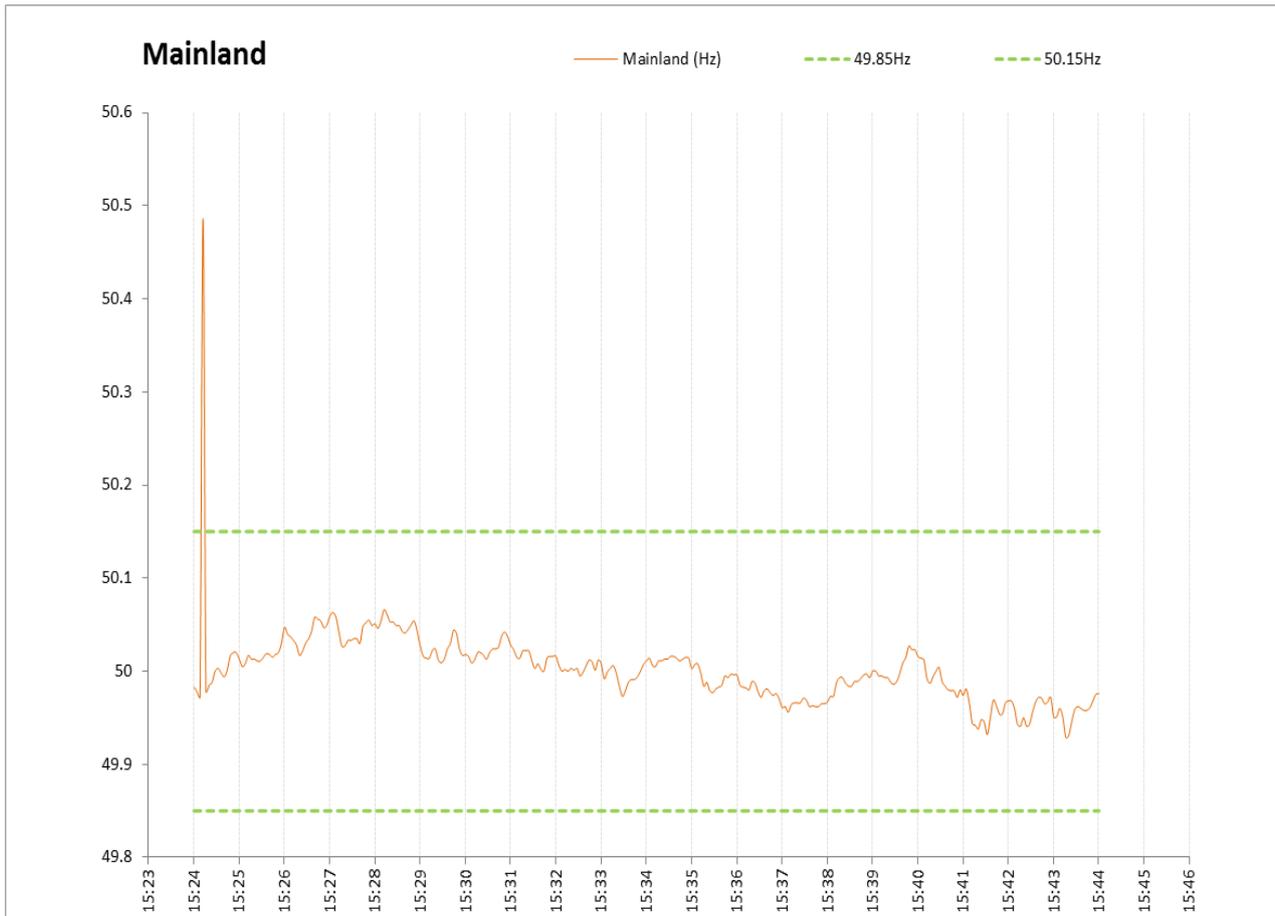


Figure 1: High Frequency No-Contingency Event in Mainland refers to item 1 in Table 2 with the frequency exceeding the Mainland Frequency Operating Standard.

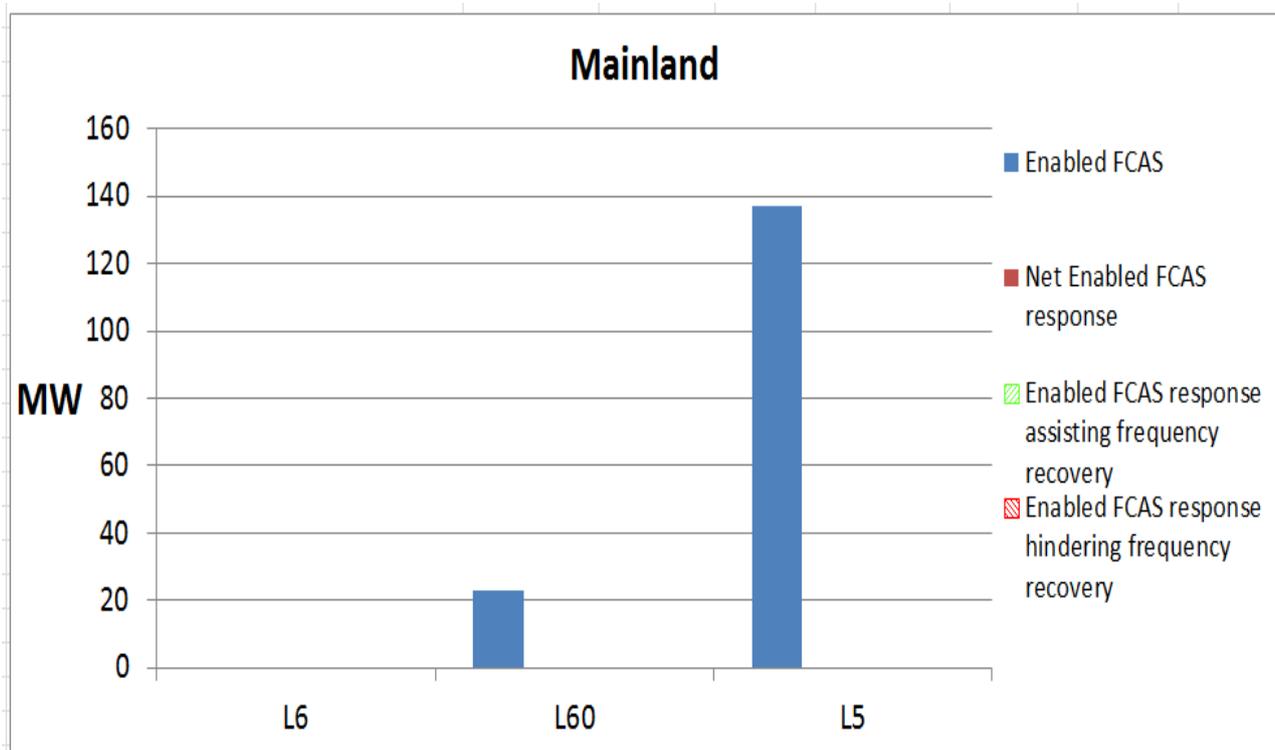


Figure 2: FCAS response to No-Contingency High Frequency Event on 23rd May 2012.

4.2 Low Frequency Events in Tasmania

There were seven Low Frequency Normal Condition Events from Table 1 recorded in Tasmania region during May 2012 that resulted in frequencies below 49.75 Hz. All of these events listed in Table 3 did not meet the Tasmania Frequency Operating Standards.

Table 3 : Events in the Tasmania region resulting in frequency exceeding the Tasmania Frequency Operating Standards.

DATE	EVENT	MIN FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)(SECONDS)
5/05/2012 01:42:48	No condition causing the event was identified.	49.59	24
05/05/2012 02:06:16	No condition causing the event was identified.	49.71	76
06/05/2012 07:50:24	No condition causing the event was identified.	49.74	24
08/05/2012 02:05:44	No condition causing the event was identified.	49.69	8
10/05/2012 03:56:40	No condition causing the event was identified.	49.73	16
18/05/2012 02:43:00	No condition causing the event was identified.	49.74	32
21/05/2012 00:55:40	No condition causing the event was identified.	49.7	264

4.2.1 Event: 05/05/2012 01:42:48

For the Normal (Non-Contingency) low frequency event on 5th May 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. Five Tasmanian generating units were coming offline following with five minutes offset 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 4. The flow across Basslink was approximately 450 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller delivered about 20 MW additional FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver slow or 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.

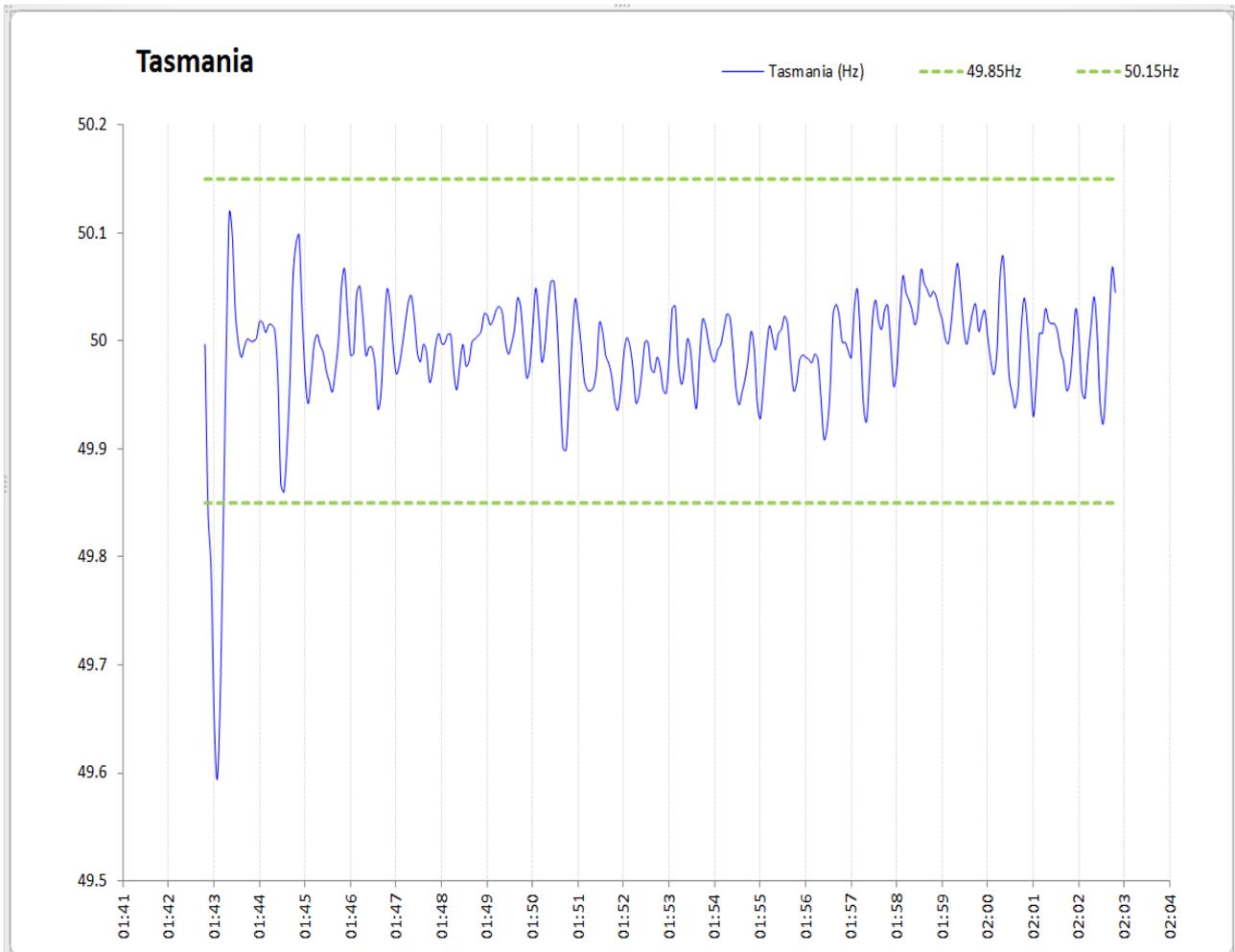


Figure 3: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 1 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

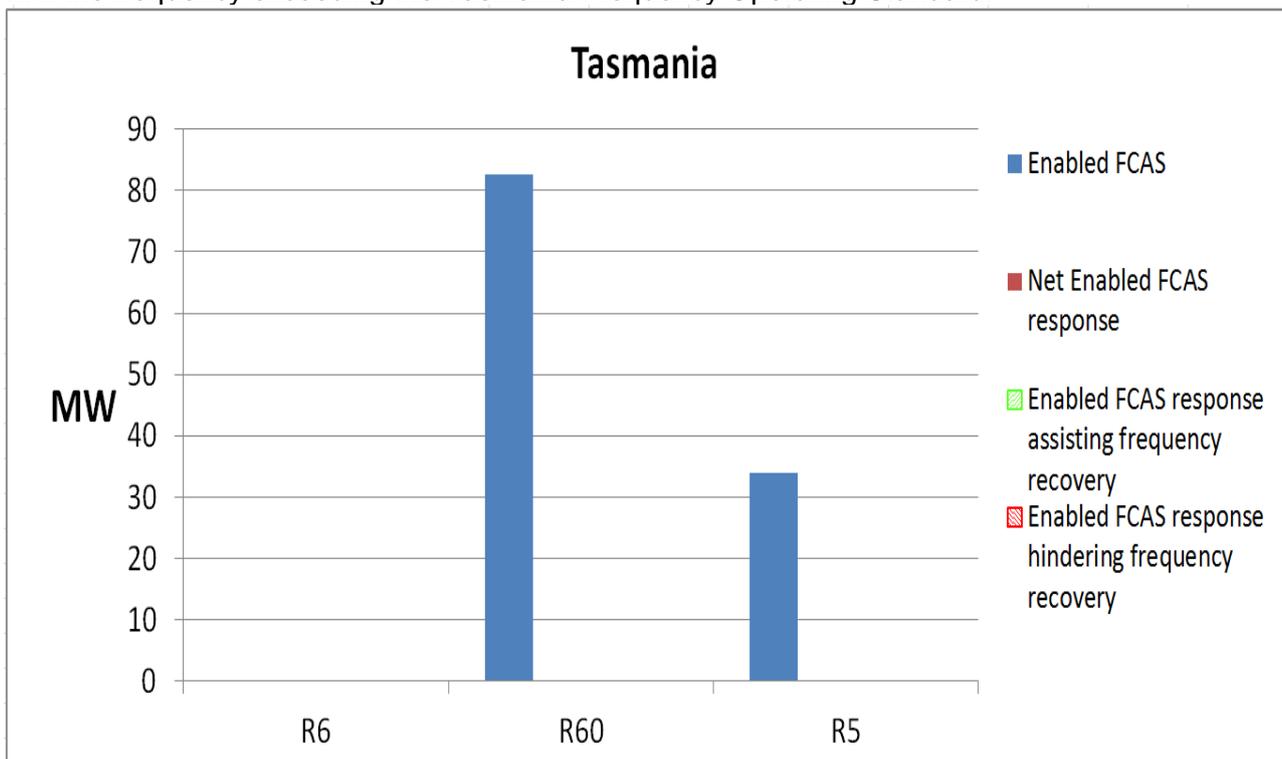


Figure 4: FCAS response to Normal (No-Contingency) Low Frequency Event on 5th May 2012.

4.2.2 Event: 05/05/2012 02:06:16

For the Normal (Non-Contingency) low frequency event on 5th May 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 76 seconds. One Tasmanian generating unit ramped about 5 MW below its generation target and same unit ramped down further 25 MW below its 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 457 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller delivered about 14 MW additional FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver slow or delayed FCAS during the event. Frequency fell to a minimum of 49.71 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 also shows another low frequency excursion with minimum frequency of 49.78 Hz that occurs soon after at 0215 hrs. This relates to another Normal Event in the Tasmania region and is within the Tasmania Frequency Operating Standards.

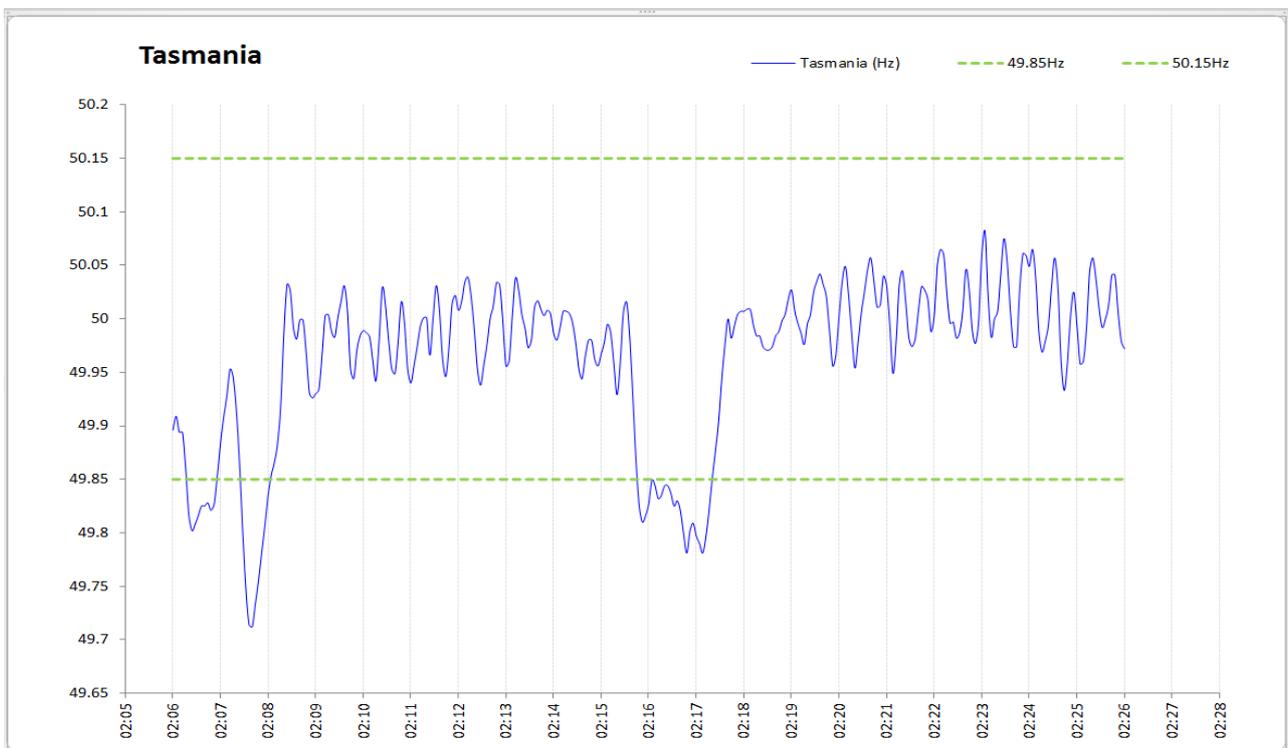


Figure 5: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 2 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

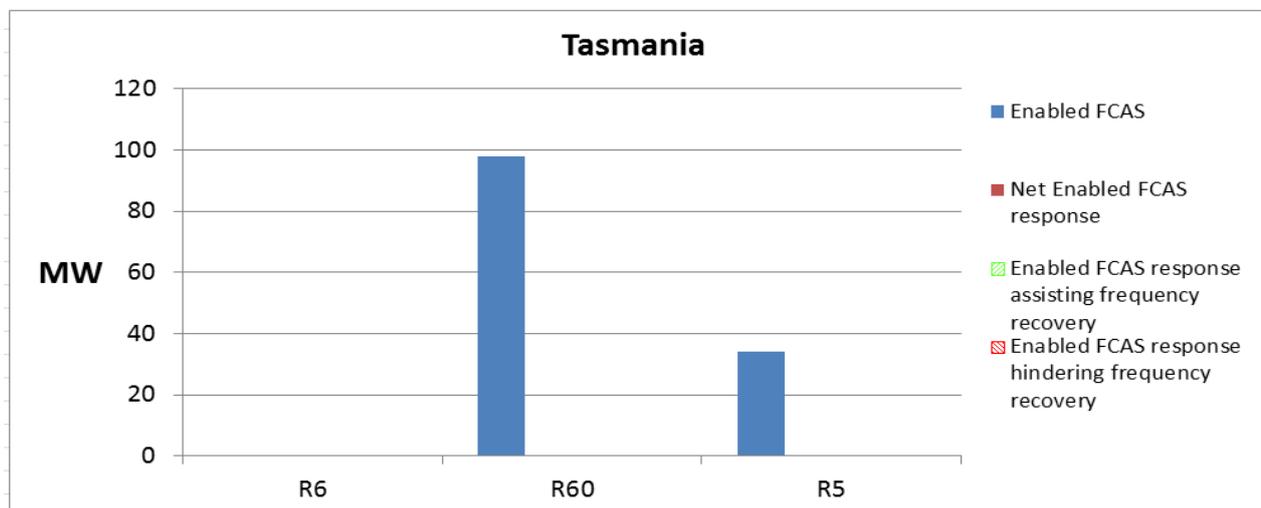


Figure 6: FCAS response to Normal (No-Contingency) Low Frequency Event on 5th May 2012.

4.2.3 Event: 06/05/2012 07:50:24

For the Normal (Non-Contingency) low frequency event on 6th May 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 24 seconds. One Tasmanian generating unit ramped about 8 MW below its 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 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 slow or 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.

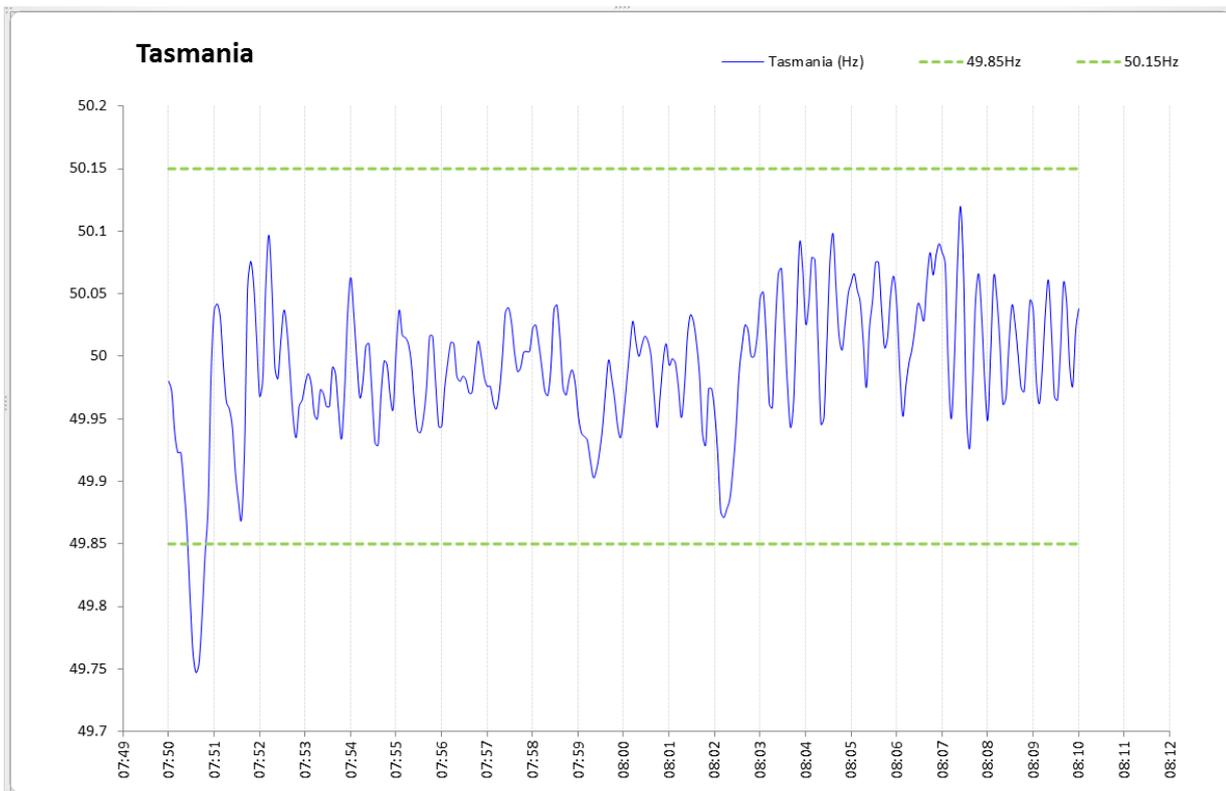


Figure 7: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 3 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

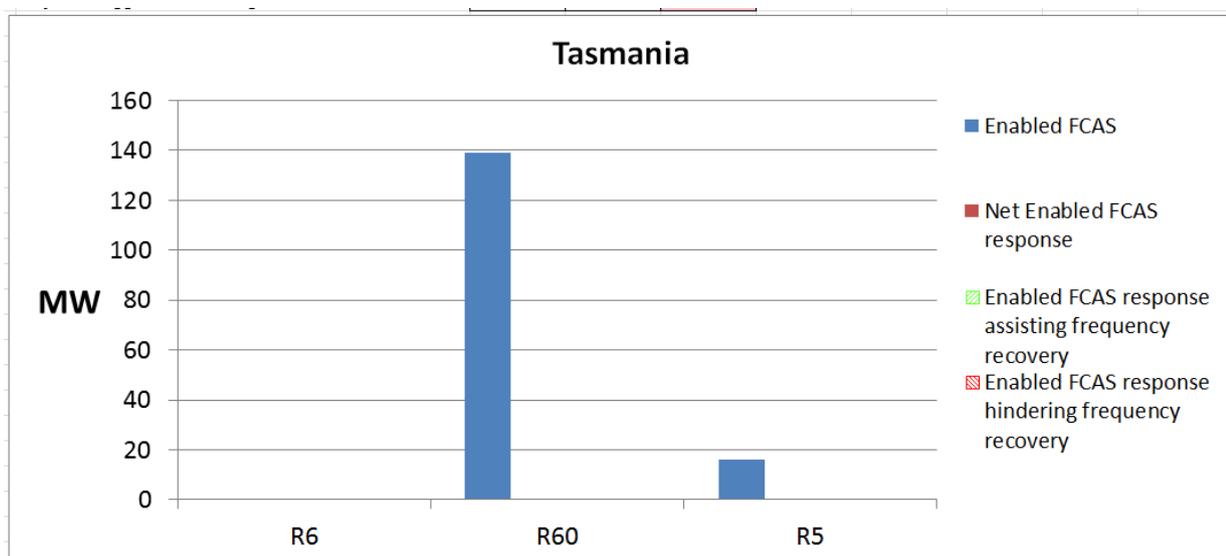


Figure 8: FCAS response to Normal (No-Contingency) Low Frequency Event on 6th May 2012.

4.2.4 Event: 08/05/2012 02:05:44

For the Normal (Non-Contingency) low frequency event on 8th May 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 8 seconds. Three Tasmanian generating units ramped down to zero MW from 5 MW, 5 MW & 10 MW respectively while coming offline with five minutes offset to their respective generation targets, concurrently two Tasmanian loads increased by about 5 MW. These changes in generation and loads contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, a zero amount was delivered as shown in Figure 10. The flow across Basslink was approximately 375 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller delivered about 44 MW of further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver slow or 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.

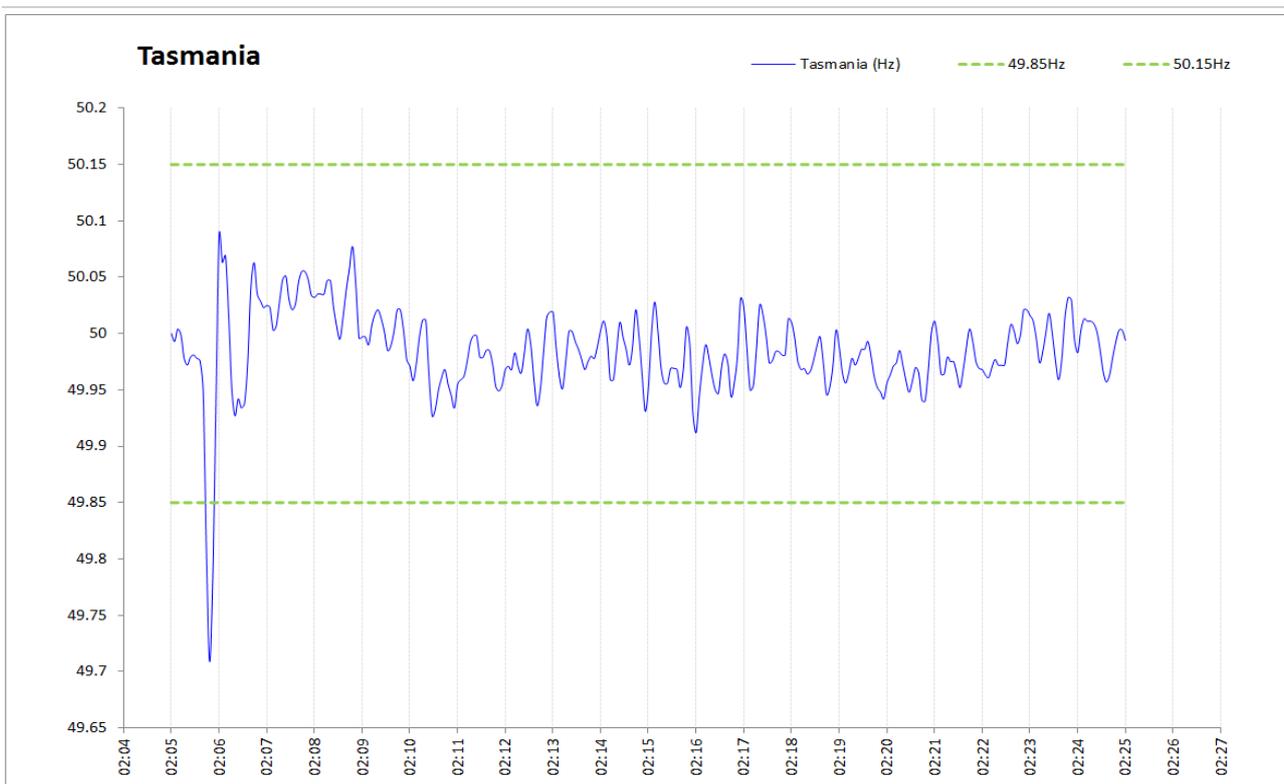


Figure 9: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 4 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

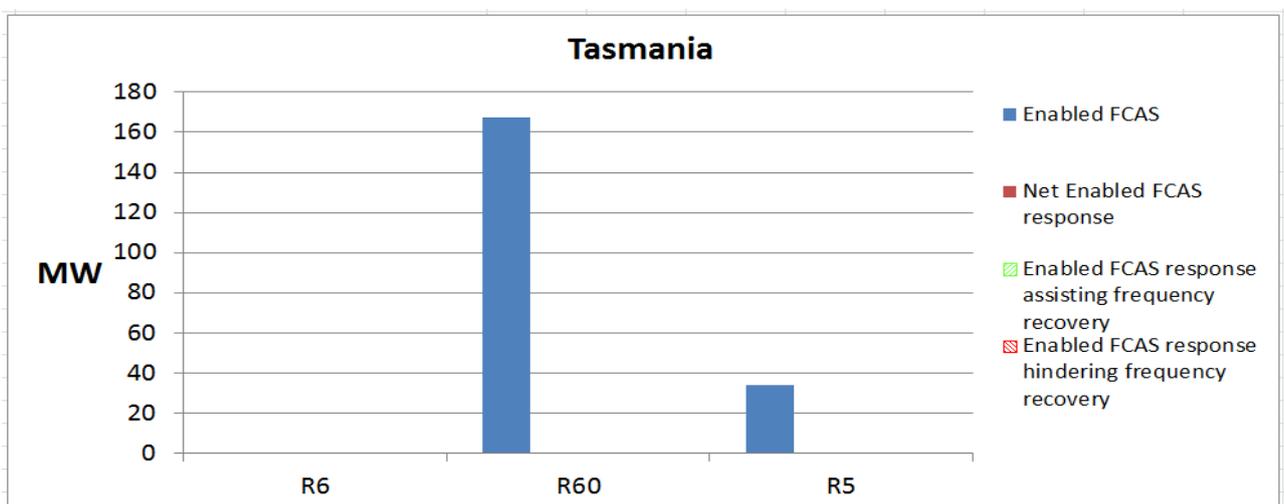


Figure 10: FCAS response to Normal (No-Contingency) Low Frequency Event on 8th May 2012.

4.2.5 Event: 10/05/2012 03:56:40

For the Normal (Non-Contingency) low frequency event on 10th May 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 16 seconds. Two Tasmanian generating units ramped down below 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 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 slow or 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.

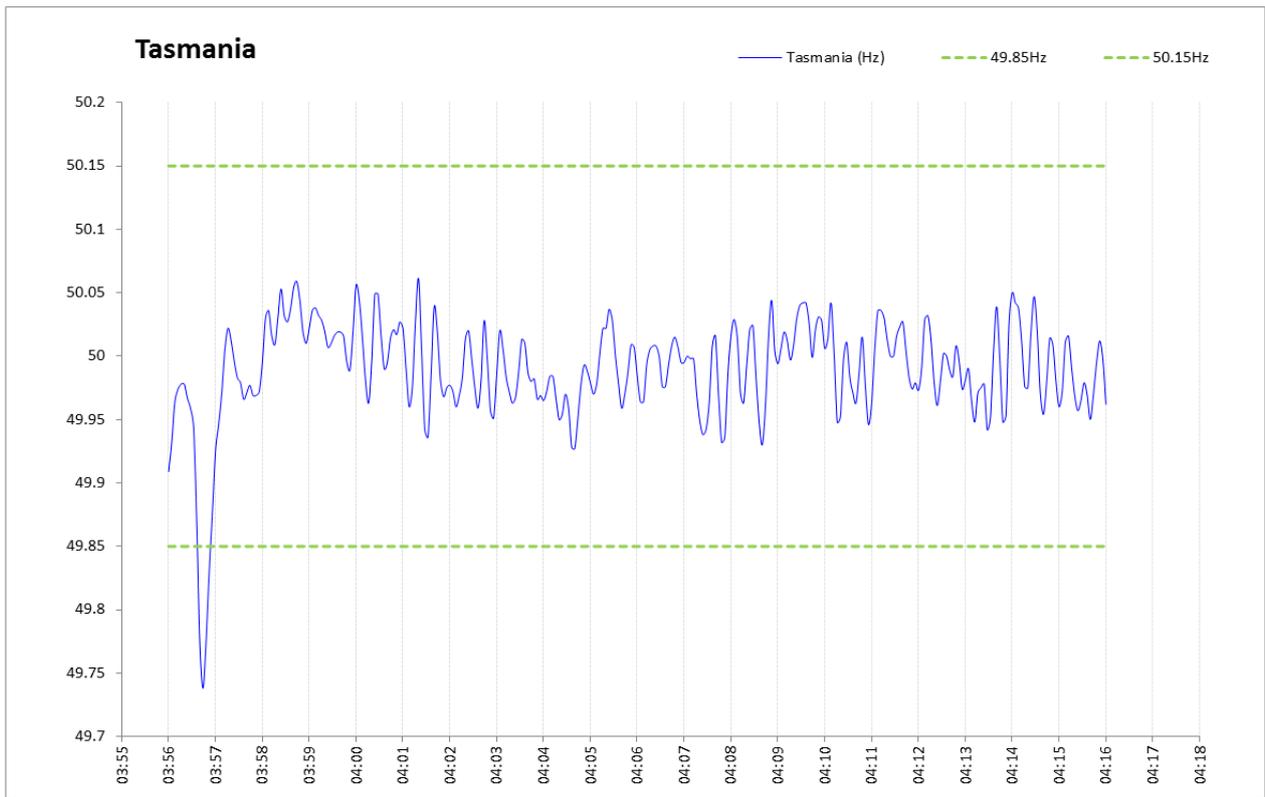


Figure 11: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 5 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

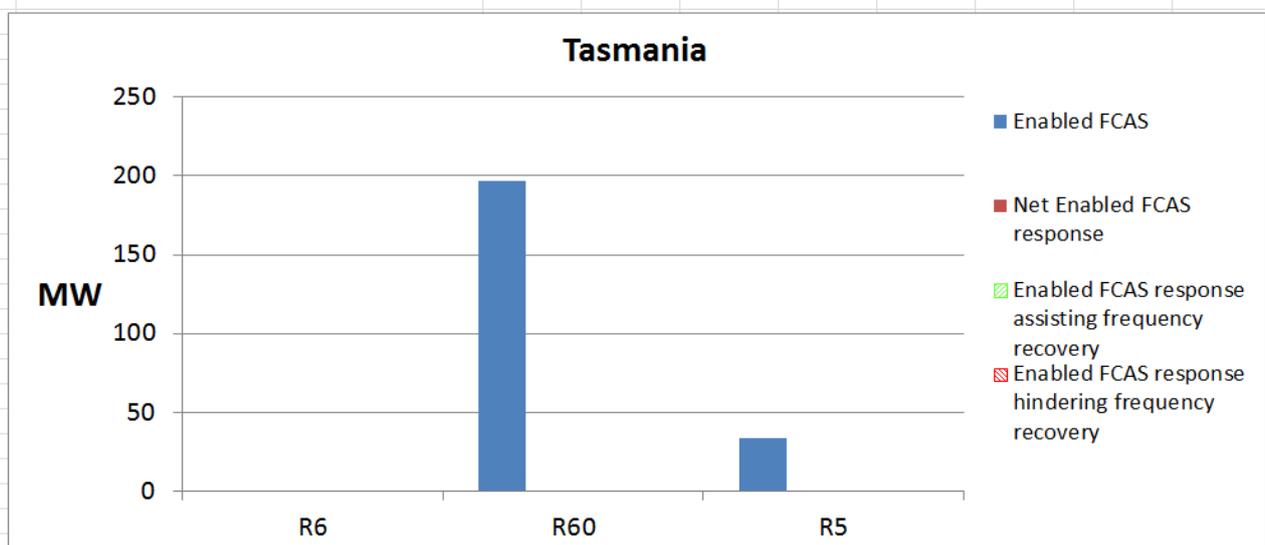


Figure 12: FCAS response to Normal (No-Contingency) Low Frequency Event on 10th May 2012.

4.2.6 Event: 18/05/2012 02:43:00

For the Normal (Non-Contingency) low frequency event on 18th May 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 32 seconds. One Tasmanian generating unit ramped down below its generation target, concurrently one Tasmanian load also increased by about 16 MW. Both these changes in generation and load 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 457 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller delivered about 14 MW of further FCAS from Mainland to Tasmania during this event. The frequency excursion was not sufficient to trigger switched controllers to deliver slow or 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.

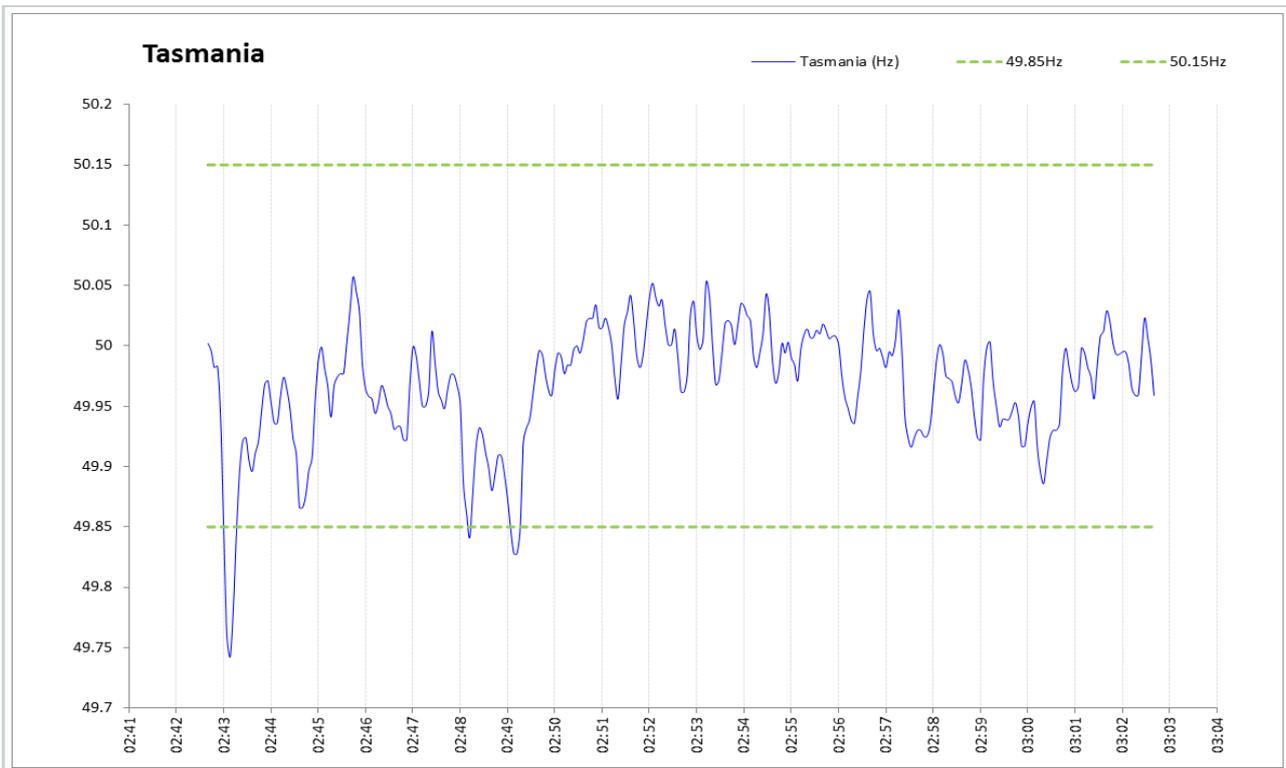


Figure 13: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 6 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

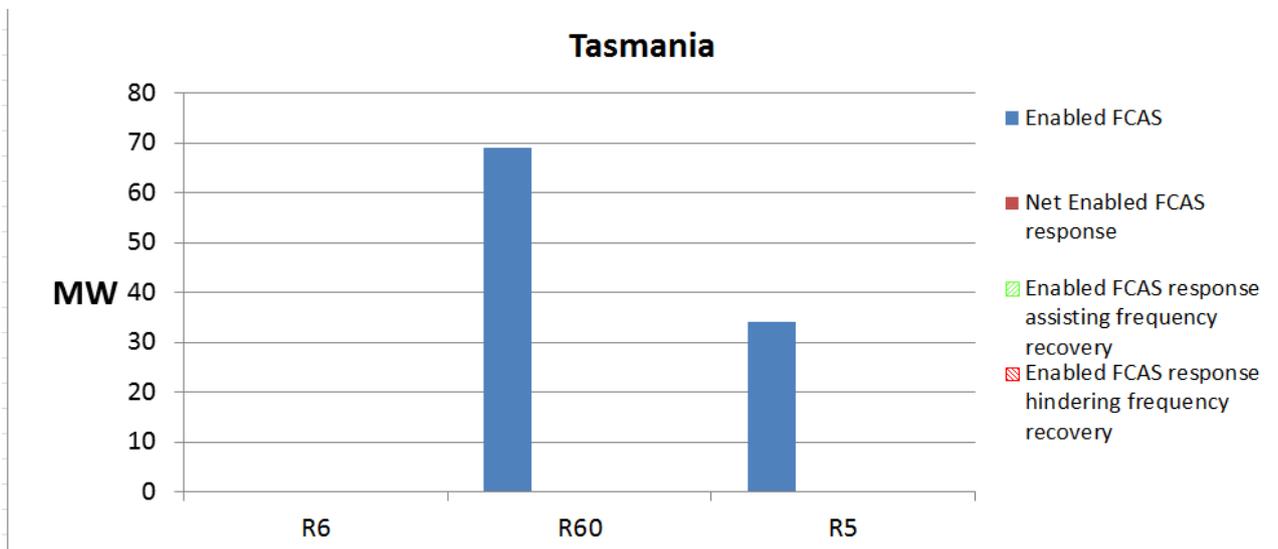


Figure 14: FCAS response to Normal (No-Contingency) Low Frequency Event on 18th May 2012.

4.2.7 Event: 21/05/2012 00:55:40

For the Normal (Non-Contingency) low frequency event on 21st May 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 264 seconds. One Tasmanian generating unit ramped up slowly with a five minutes offset to its generation target which resulted the same generating unit to be about 50 MW below its generation target during the time of the event which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, only 16 % of the slow raise FCAS was delivered as shown in Figure 16. The flow across Basslink was approximately 45 MW towards Mainland during the time of the frequency excursion. Basslink cannot transfer any 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 the time of this event. The frequency excursion was not sufficient to trigger switched controllers to deliver slow or delayed FCAS during the event. Frequency fell to a minimum of 49.70 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.

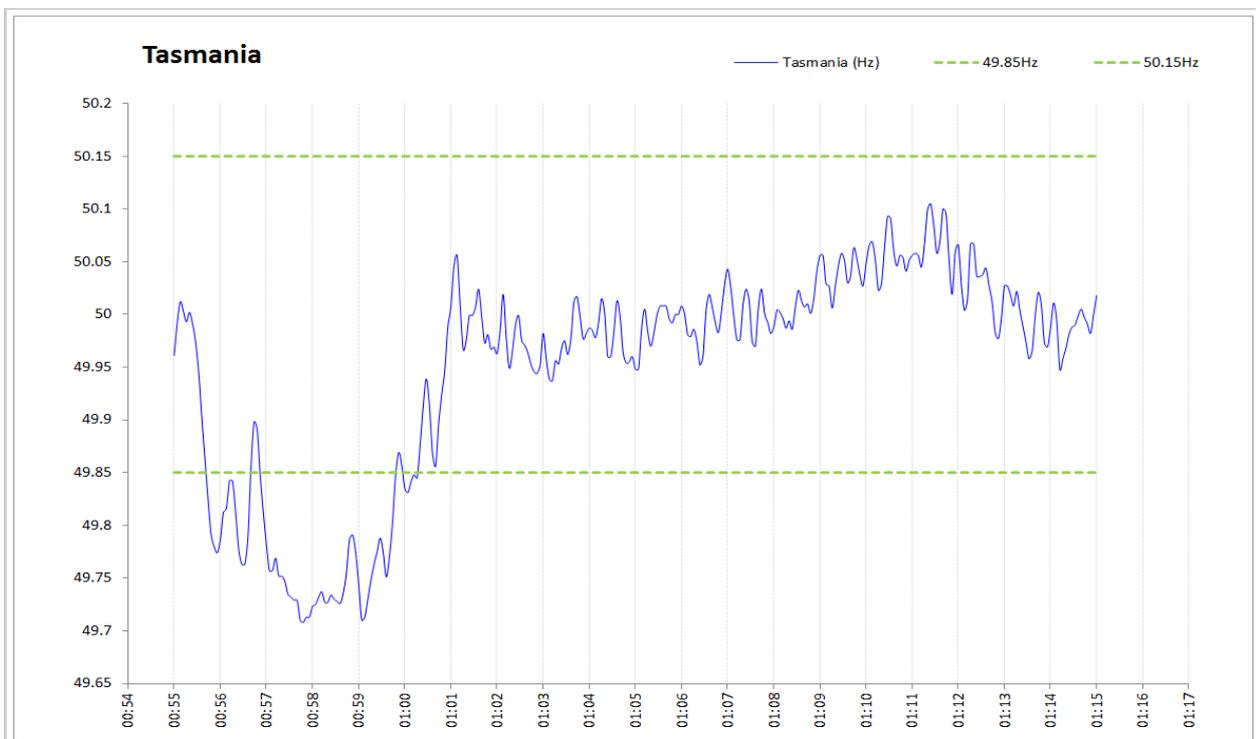


Figure 15: Low Frequency Normal (No-Contingency) Event in Tasmania refer to item 7 in Table 3 with the frequency exceeding the Tasmania Frequency Operating Standard.

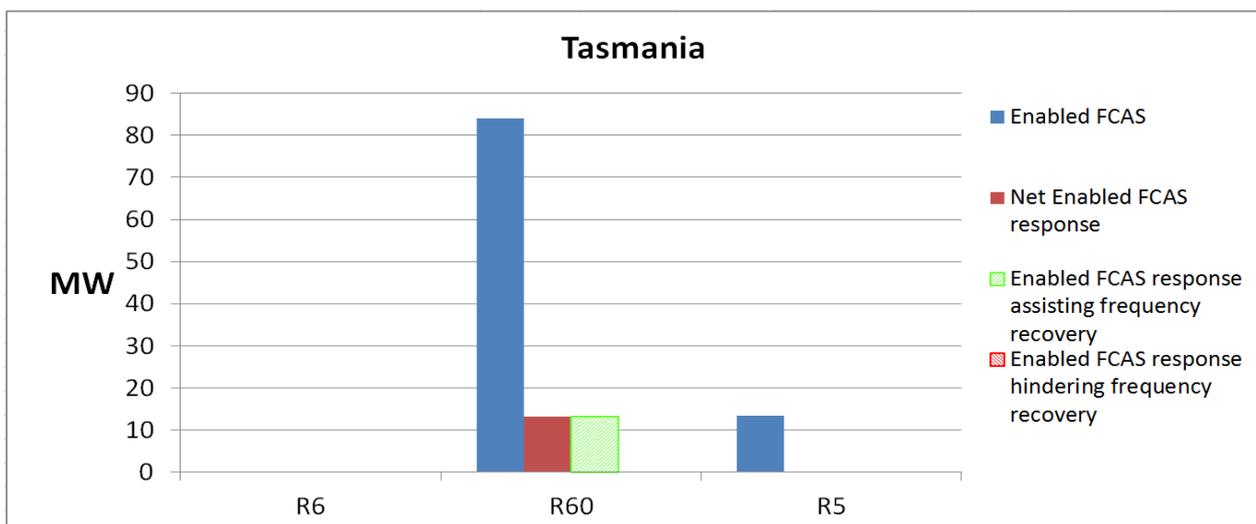


Figure 16: FCAS response to Normal (No-Contingency) Low Frequency Event on 21st May 2012.

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 May 2012.

Frequency in the Mainland regions was within the range 49.92 Hz to 50.06 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 Hz for greater than 99.99 % of the time. The mean value of frequency during May 2012 was 50.00 Hz with a standard deviation of 0.027 Hz.

Frequency in the Tasmania region was within the range 49.89 Hz – 50.09 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 Hz for 99.99 % of the time. The mean value of frequency during May 2012 was 50.00 Hz with a standard deviation of 0.044 Hz.

5.1.1 Daily frequency standard deviation

Figure 17 and Figure 18 below plot the daily standard deviation of the Mainland and Tasmanian frequency for the past 13 months, and do not exclude contingency events.

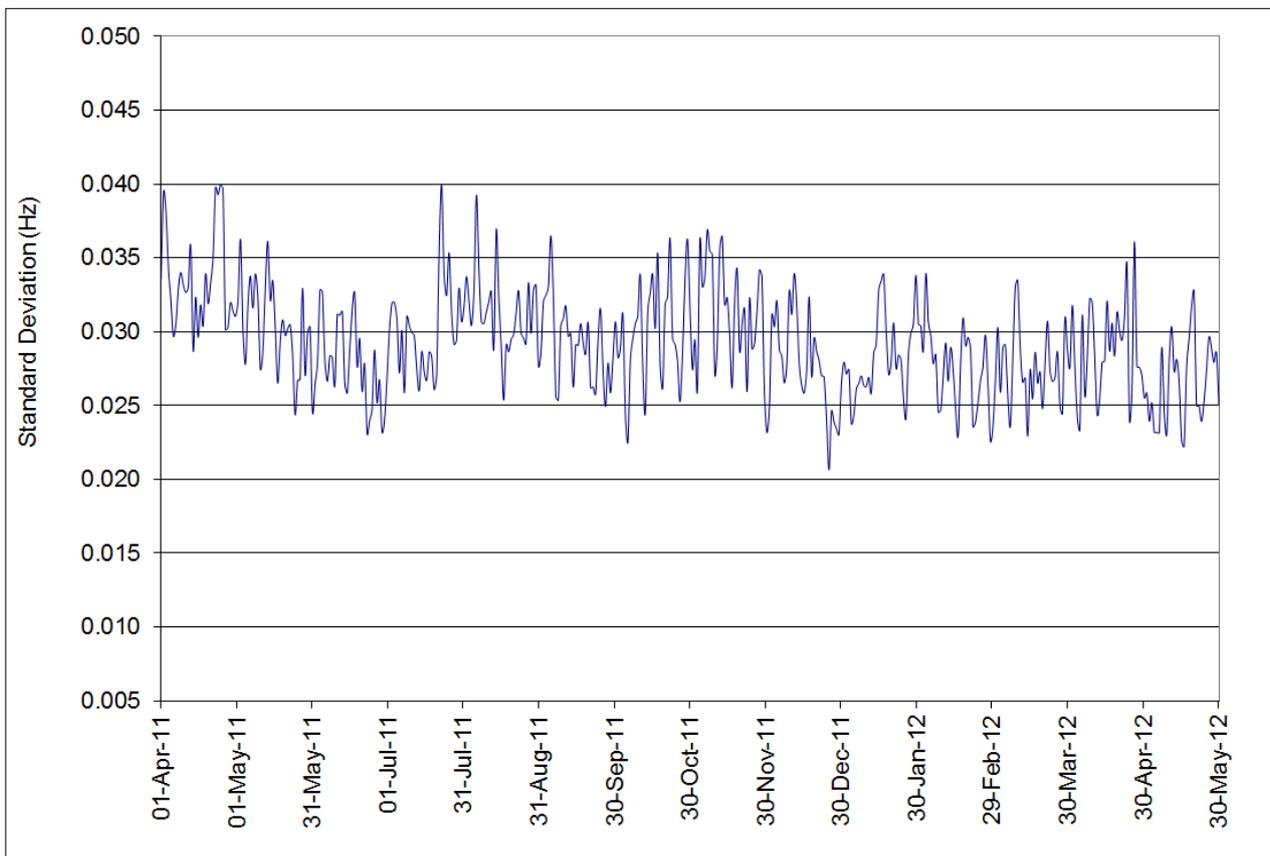


Figure 17: Daily standard deviation of Mainland frequency.

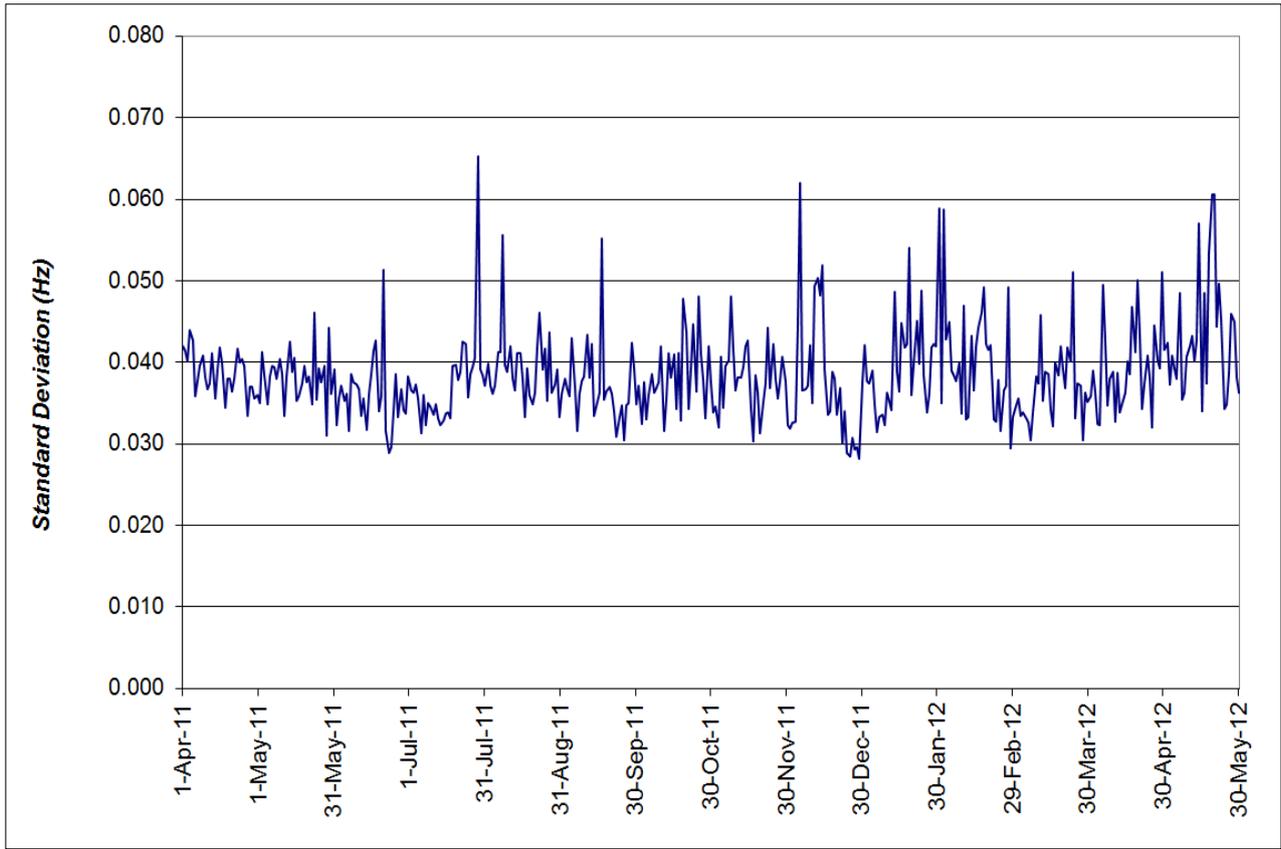


Figure 18: Daily standard deviation of frequency in Tasmania.

5.1.2 Time of day analysis

This section details the standard deviation of system frequency on a monthly and daily basis. Figure 19 and Figure 20 show the average half-hourly standard deviation of the Mainland regions and Tasmania frequency for March, April and May 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 19 and Figure 20 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).

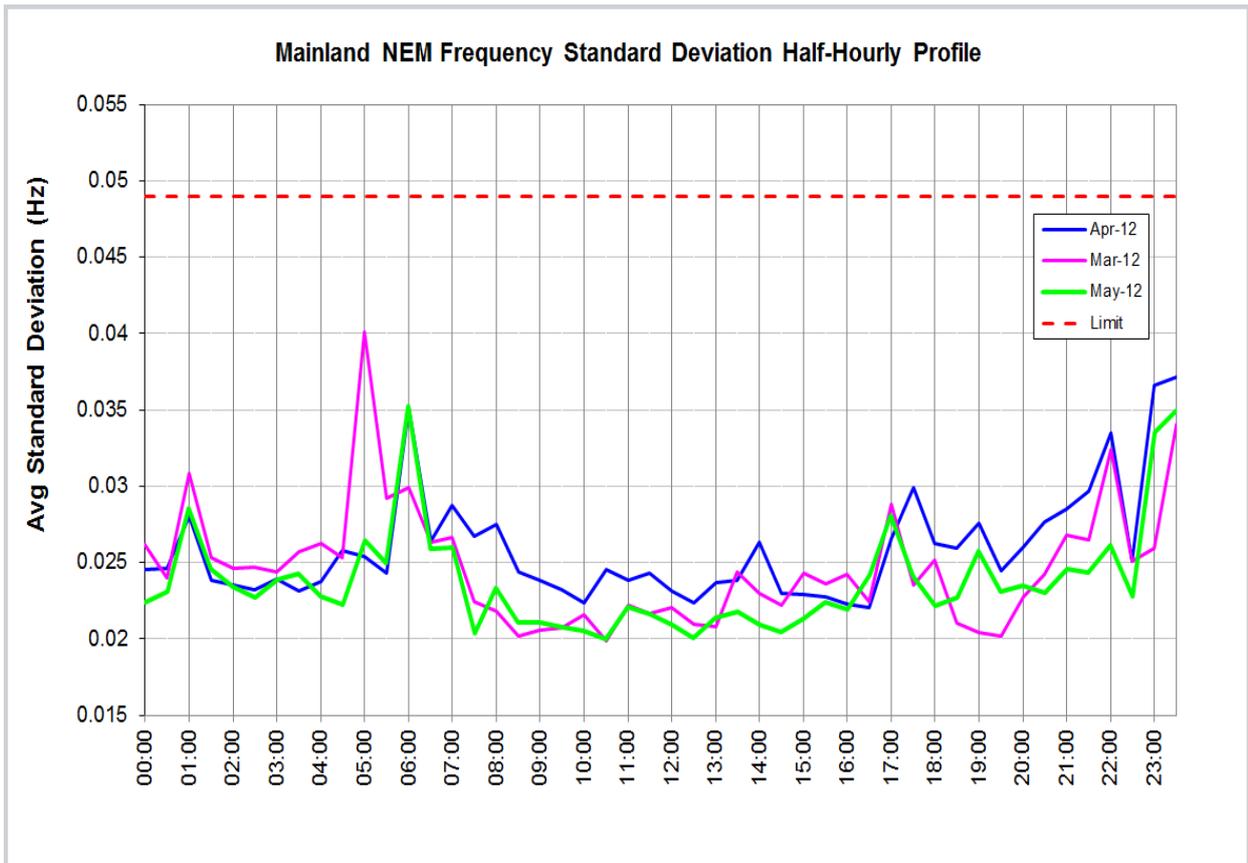


Figure 19: Daily profile of standard deviation for the frequency in the Mainland regions.

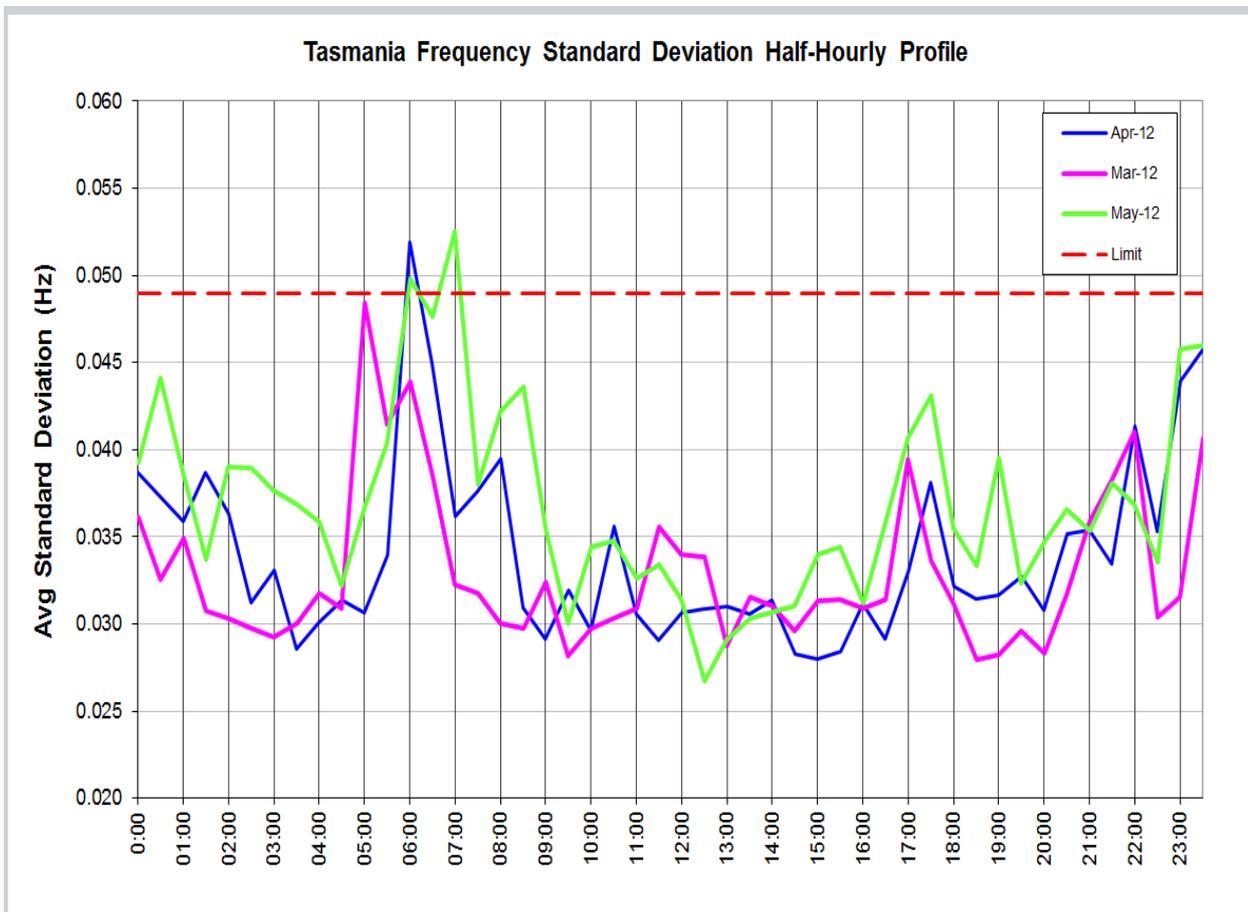


Figure 20: Daily profile of standard deviation for the frequency in Tasmania.

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 May 2012 is provided in Table 4.

Table 4: Accumulated time deviation statistics.

	QLD	NSW	VIC	SA	TAS
Maximum Positive Deviation (s)	1.56	1.78	0.72	3.15	5.97
Maximum Negative Deviation (s)	-3.67	-3.44	-6.87	-5.28	-8.02
Mean Value (s)	-0.161	0.040	-1.077	0.398	0.140
Standard Dev (s)	0.637	0.637	0.670	0.757	2.354

The distribution of time deviations based on the Mainland and Tasmania region measurements are provided in Figure 21 and Figure 22.

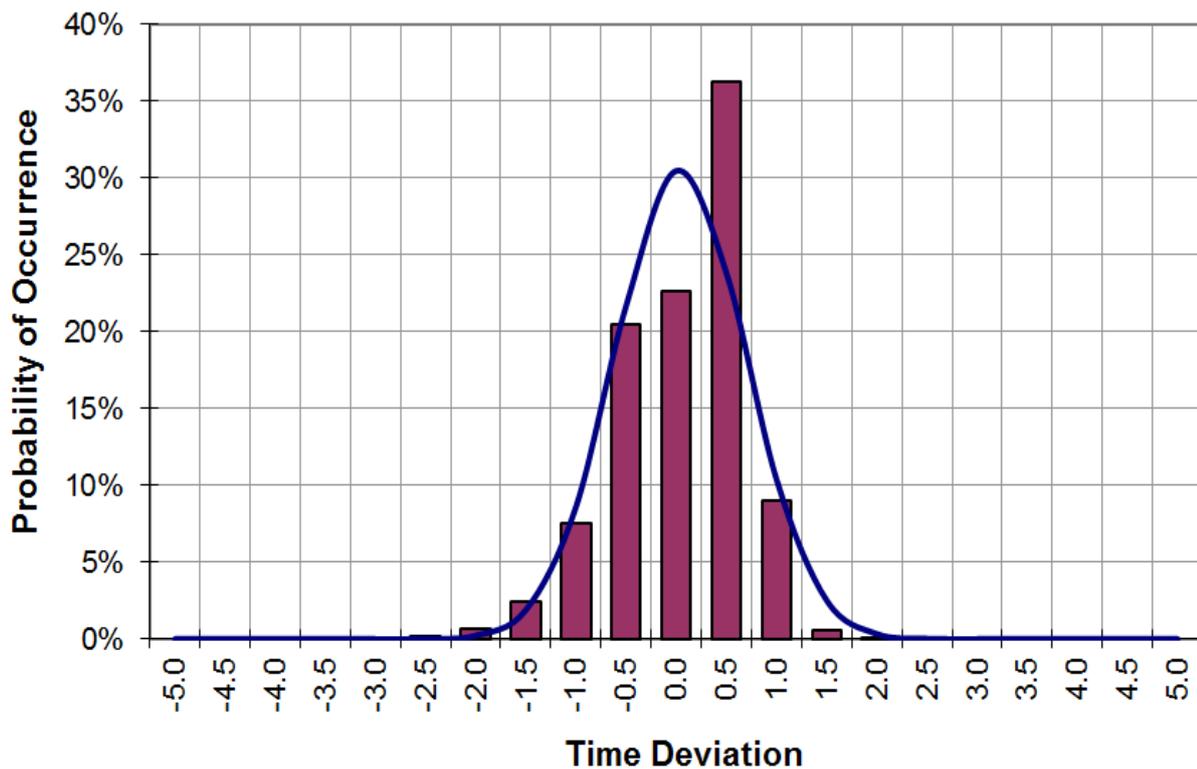


Figure 21: Mainland time deviation distribution for May 2012.

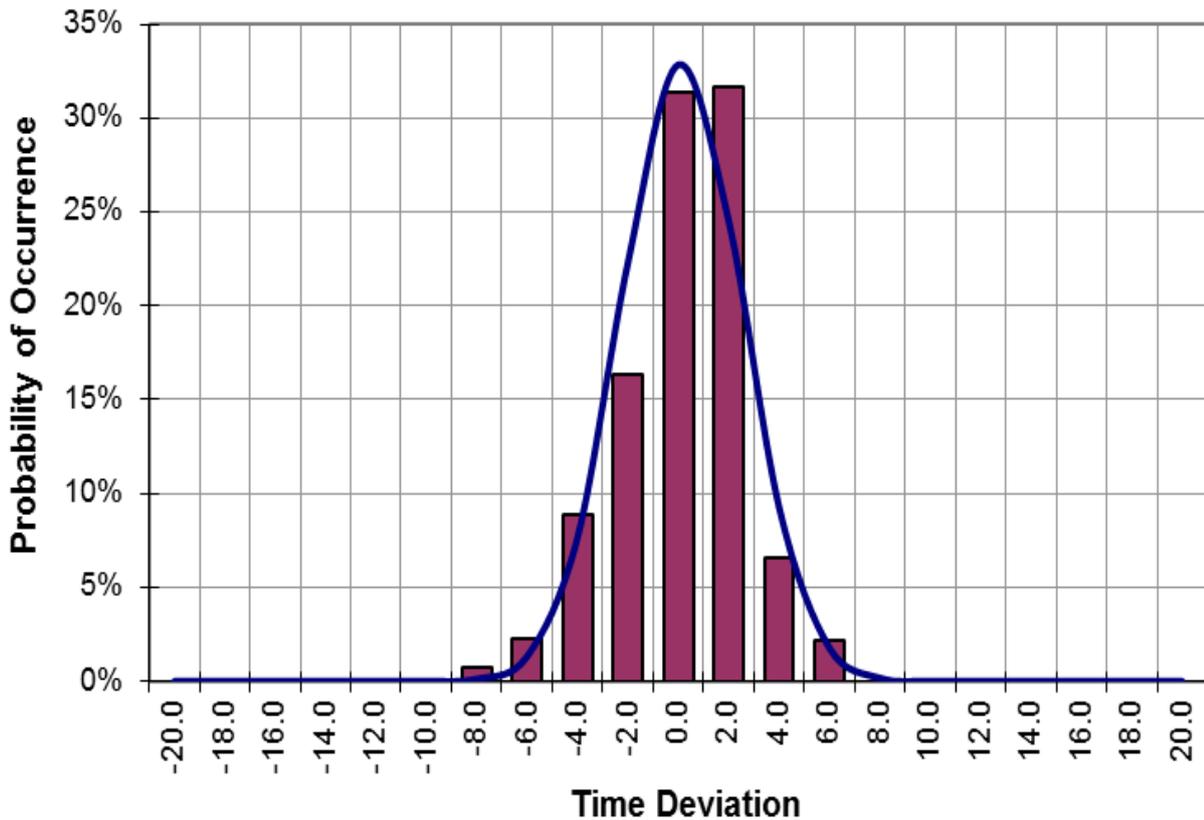


Figure 22: Tasmania time deviation distribution for May 2012.

6.1 Time error performance

Figure 23 and Figure 24 below present the daily maximum and minimum values of the Mainland and Tasmania regions time error observed for the past 13 months.

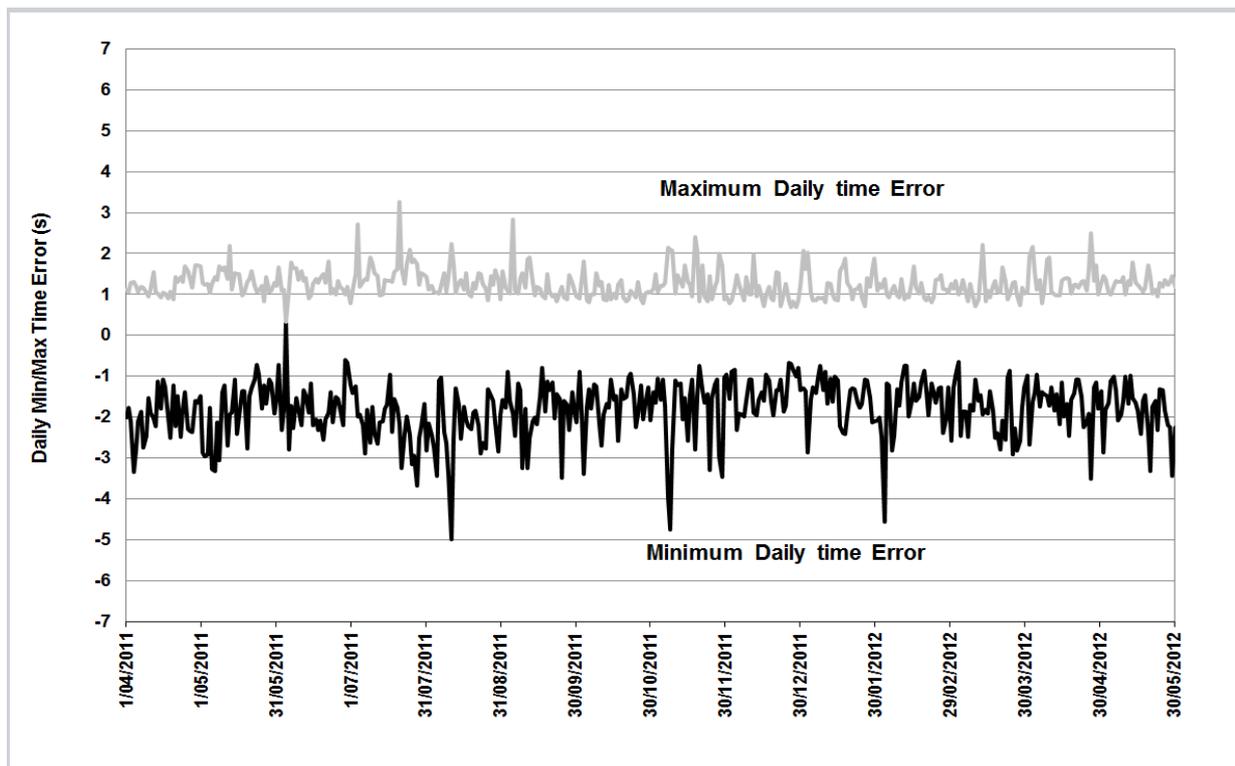


Figure 23: Mainland regions daily maximum and minimum time deviation.

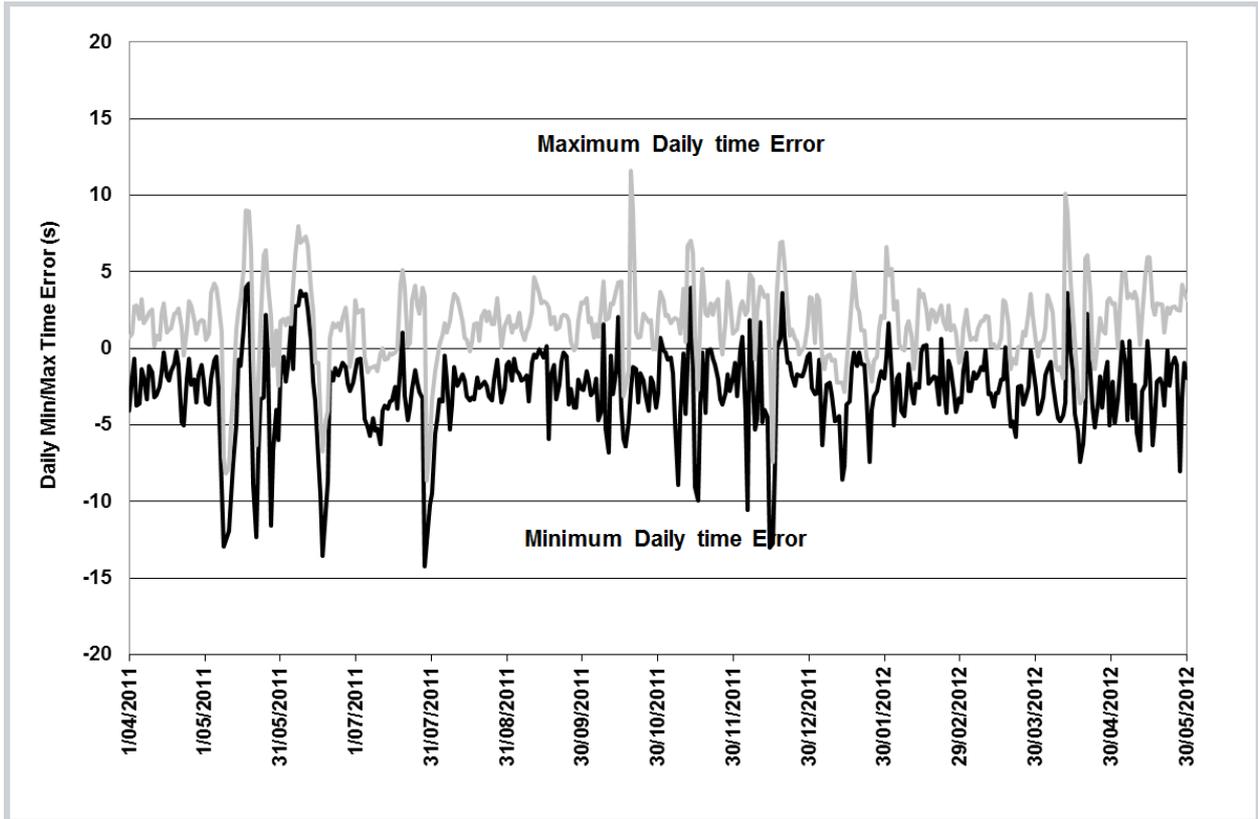


Figure 24: Tasmania daily maximum and minimum time deviation.