

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 April 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 Guidelines²” 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-millisecond or higher resolution) data and is only presented in this report for events where the appropriate data is available.

Table 1 over page summarises events in the Mainland and Tasmanian regions for the month April 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	37
	HIGH	0	23
Load Event	LOW	0	94
	HIGH	1	97
Generation Event	LOW	2	3
	HIGH	0	0
Network Event	LOW	0	0
	HIGH	0	1
Separation Event	LOW	0	0
	HIGH	0	0
Multiple Contingency Event	LOW	0	2
	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 1 as not meeting the frequency operating standard applicable to each event.

4.1 Frequency Events in Mainland Region

There were no events recorded in Mainland Region that did not meet the Mainland Frequency Operating Standards from those identified in Table 1 during April 2012.

4.2 Low Frequency Events in Tasmania

There were three Low Frequency Normal Condition Events from Table 1 recorded in Tasmania during April 2012 that resulted in frequencies below 49.75 Hz. All of these events listed in Table 2 did not meet the Tasmania Frequency Operating Standards.

Table 2: Low Frequency Normal Condition Events (No Contingency) in the Tasmania region that exceeded the Tasmania Frequency Operating Standards.

DATE	EVENT	MIN FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)
01/04/2012 02:33:56	No condition causing the event was identified.	49.71	36
27/04/2012 02:10:12	No condition causing the event was identified.	49.71	20
30/04/2012 03:23:28	No condition causing the event was identified.	49.71	76

4.2.1 Event: 1/04/2012 02:33:56

For the Normal (Non-Contingency) low frequency event on 1st April 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 36 seconds. Two Tasmanian generating units ramped down from 15 MW and 10 MW respectively to zero MW following 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 2. The flow across Basslink was approximately 427 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller delivered approximately 5 MW of FCAS from the 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.

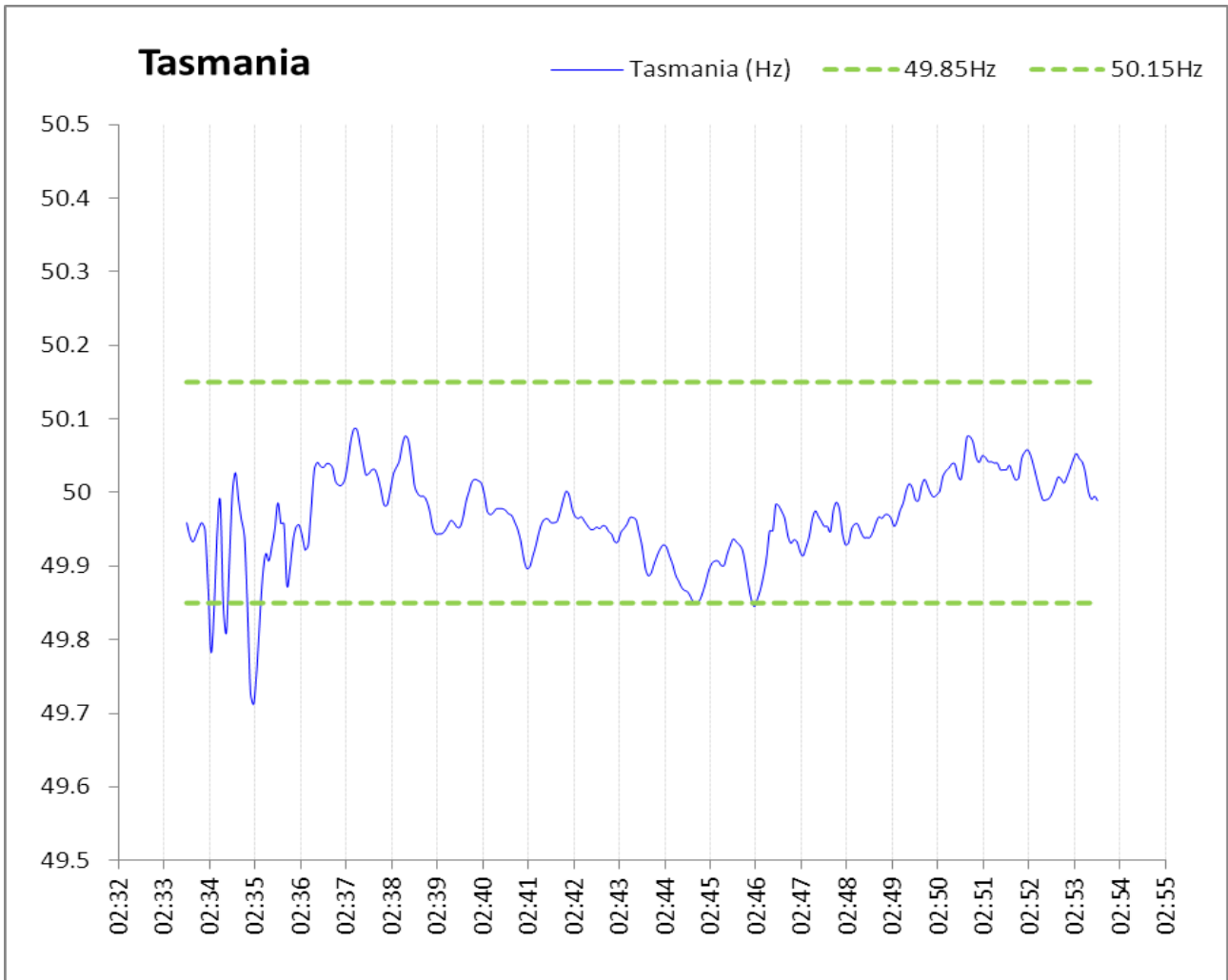


Figure 1: Low Frequency Normal Event in Tasmania refer to item 1 in Table 2 where the frequency exceeded the Tasmania Frequency Operating Standard.

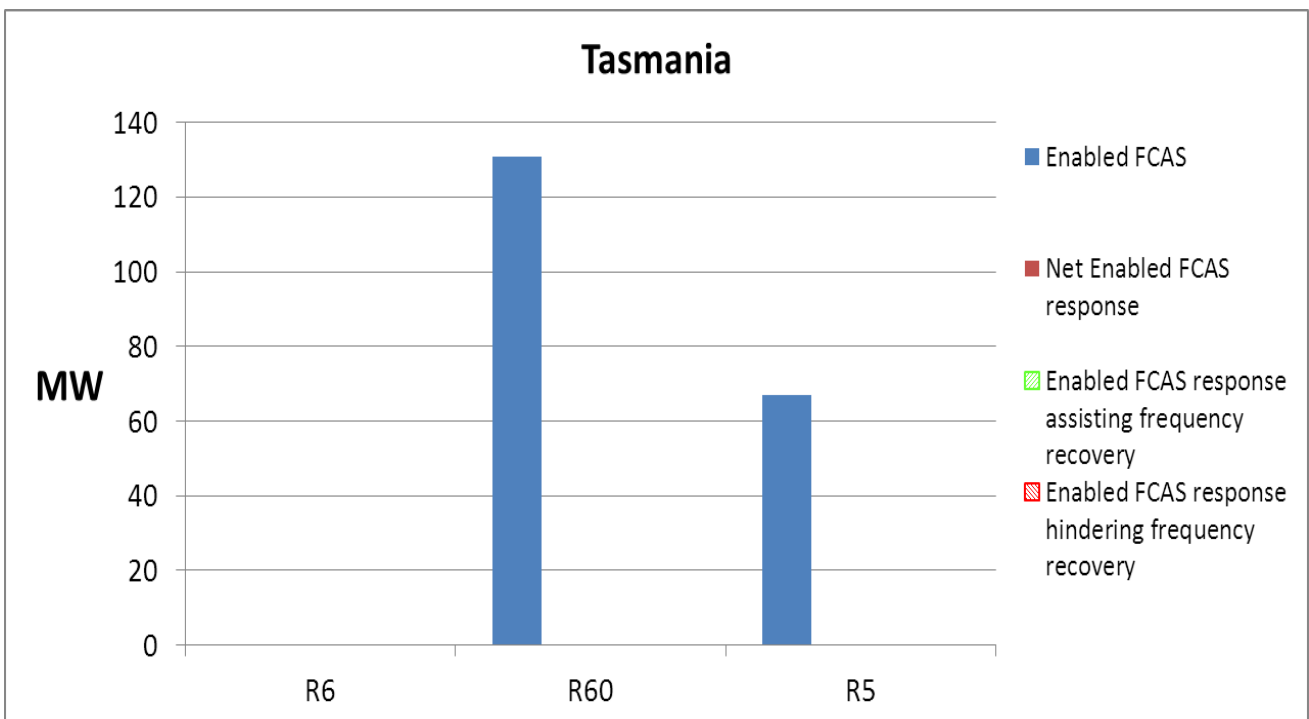


Figure 2: FCAS response to Normal (Non-Contingency) Low Frequency Event on 1st April 2012.

4.2.2 Event: 27/04/2012 02:10:12

For the Normal (Non-Contingency) low frequency event on 27th April 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 20 seconds. One Tasmanian generating unit ramped down rapidly 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 470 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from the 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.

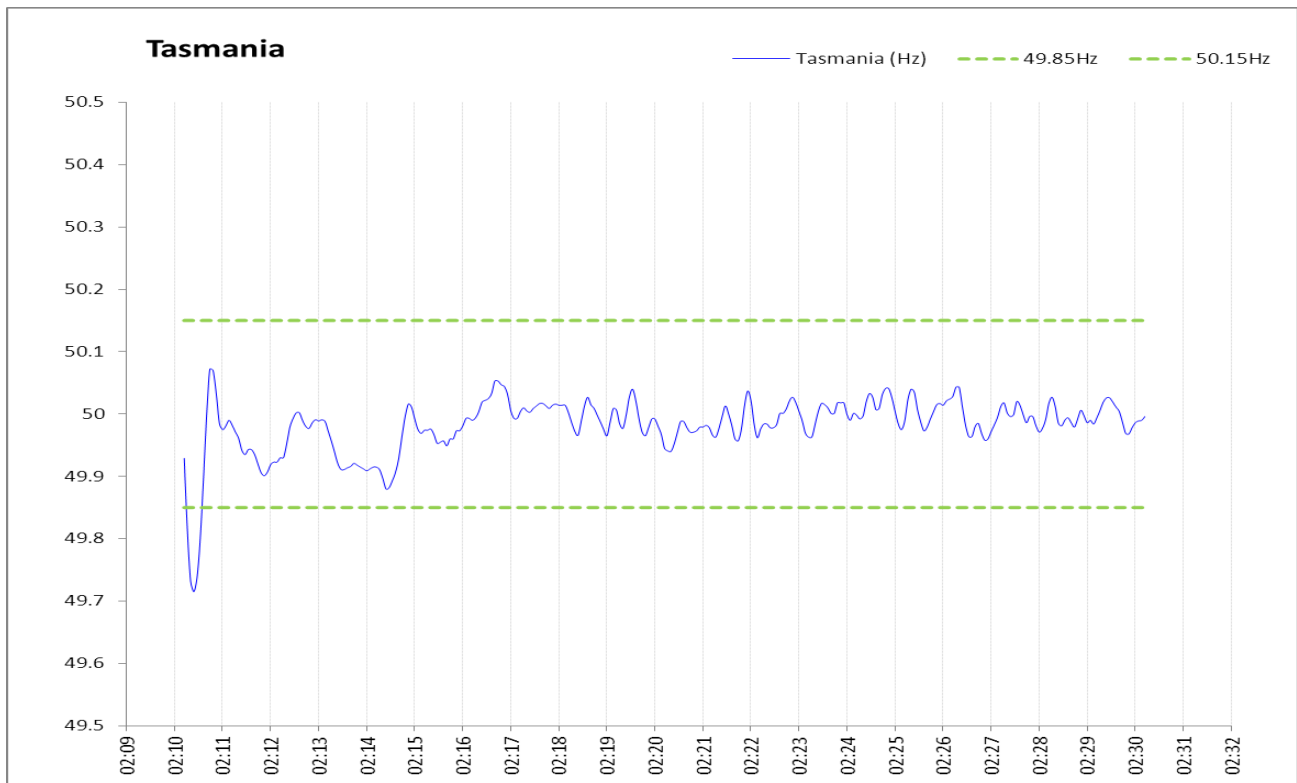


Figure 3: Low Frequency Normal Event in Tasmania refer to item 2 in Table 2 where the frequency exceeded the Tasmania Frequency Operating Standard.

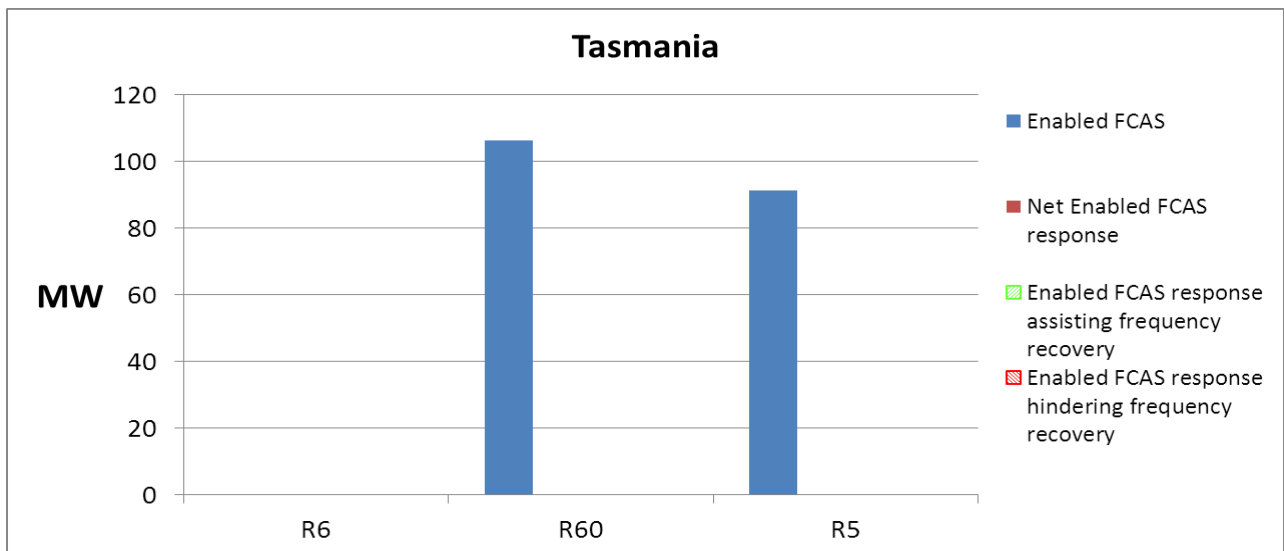


Figure 4: FCAS response to Normal (Non-Contingency) Low Frequency Event on 27th April 2012.

4.2.3 Event: 30/04/2012 03:23:28

For the Normal (Non-Contingency) low frequency event on 30th April 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. A Tasmanian generating unit ramped down from 26 MW to zero MW (in a 5 MW step and a 21 MW step) following 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 470 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not deliver any further FCAS from the 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.

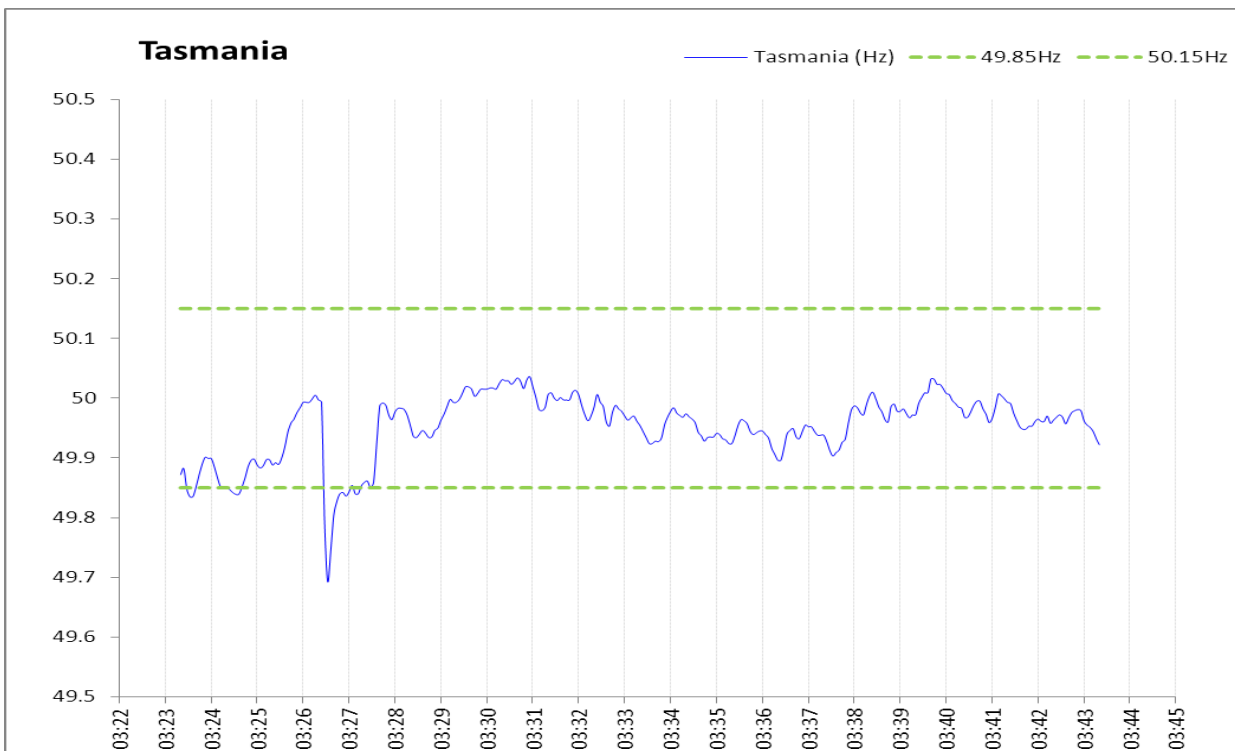


Figure 5: Low Frequency Normal Event in Tasmania refer to item 3 in Table 2 where the frequency exceeded the Tasmania Frequency Operating Standard.

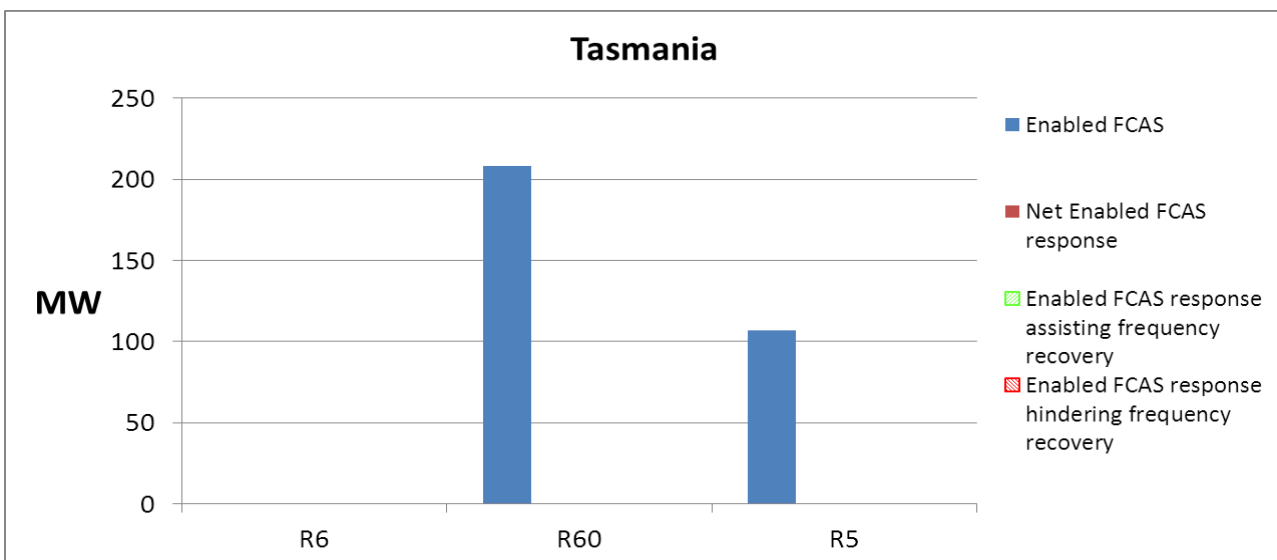


Figure 6: FCAS response to Normal (Non-Contingency) Low Frequency Event on 30th April 2012.

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 April 2012.

Frequency in the Mainland regions was within the range 49.91 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 April 2012 was 50 Hz with a standard deviation of 0.029 Hz.

Frequency in the Tasmania region was within the range 49.90 – 50.09 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 Hz for 99.98% of the time. The mean value of frequency during April 2012 was 50 Hz with a standard deviation of 0.039 Hz.

5.1.1 Daily Frequency Standard Deviation

Figure 7 and Figure 8 below plot the daily standard deviation of the Mainland and Tasmania frequency for the past 13 months, and does not exclude load and contingency events.

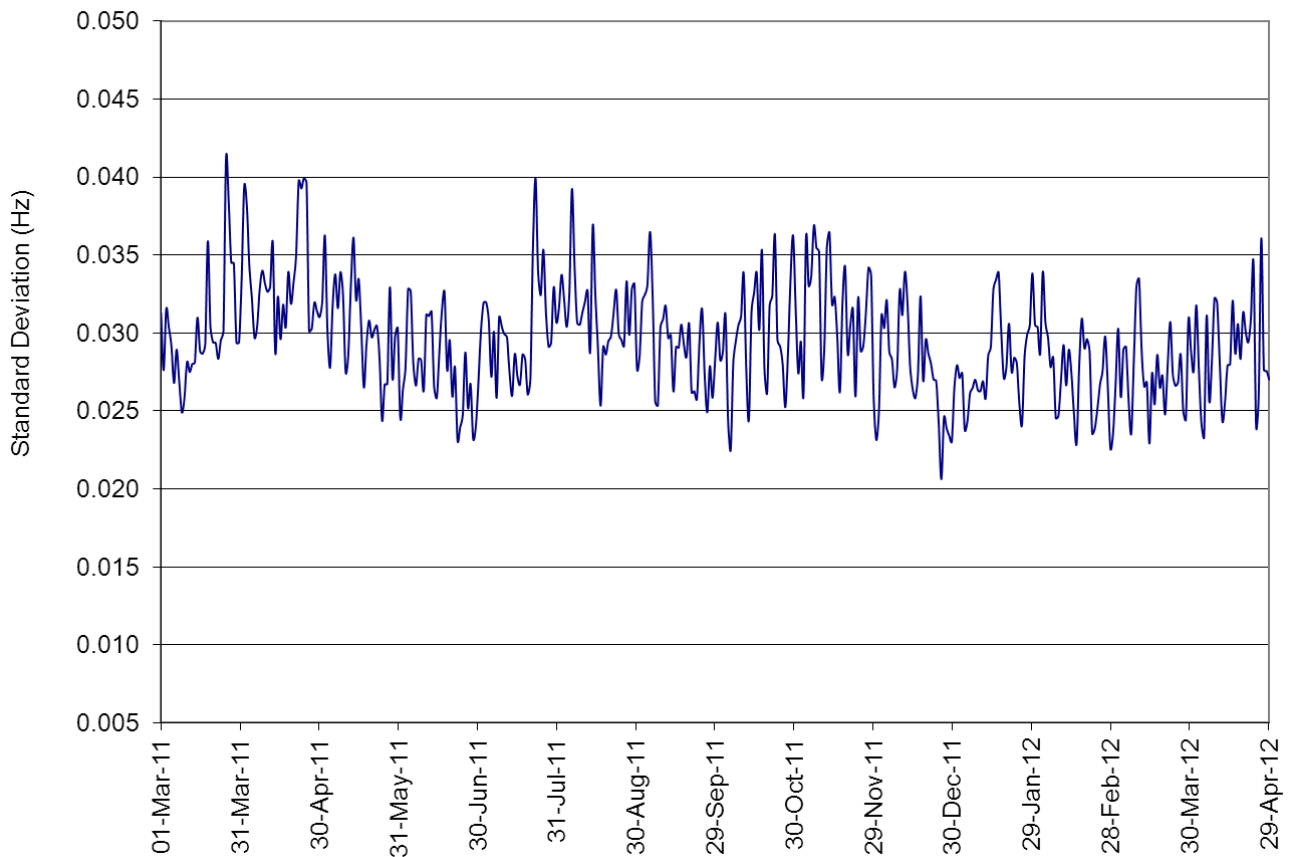


Figure 7: Daily standard deviation of Mainland frequency.

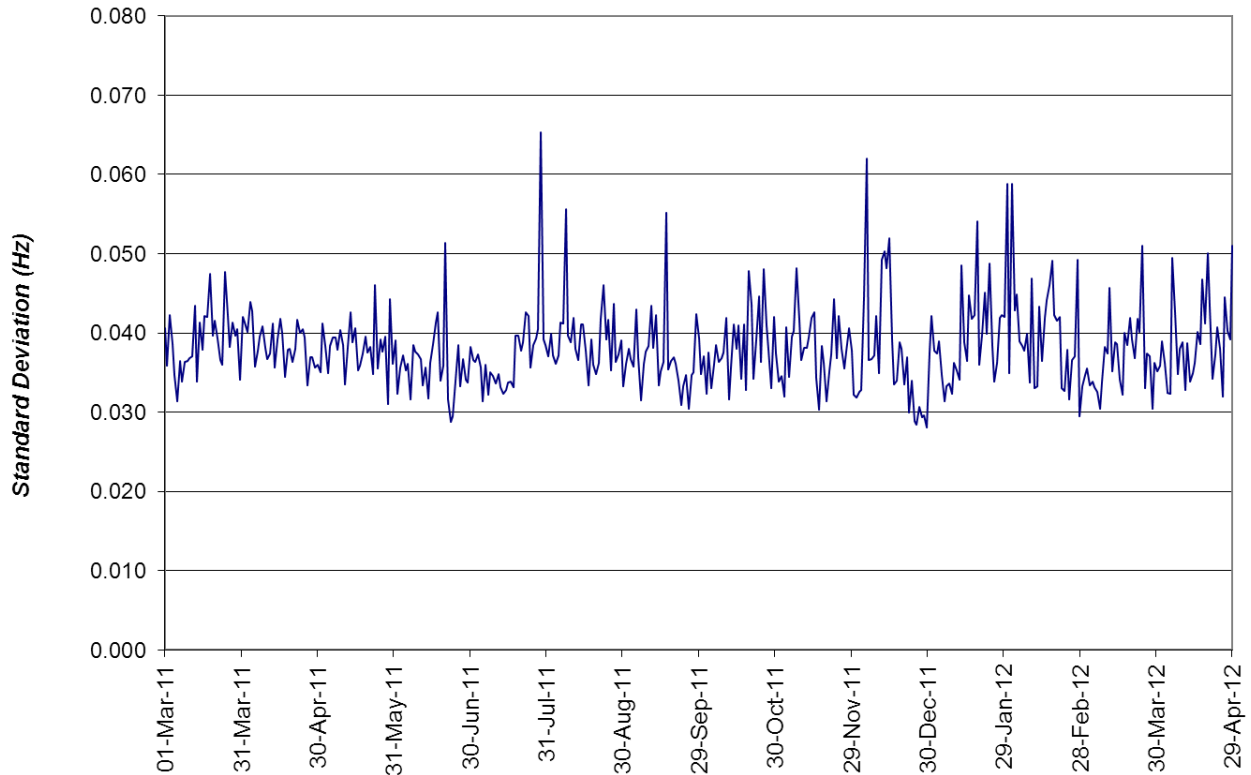


Figure 8: Daily standard deviation of frequency in Tasmania.

5.1.2 Time of day Analysis

This section details the standard deviation of system frequency on a monthly and daily basis. Figure 9 and Figure 10 show the average half-hourly standard deviation of the Mainland regions and Tasmania frequency for February, March and April 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 9 and Figure 10 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).

Mainland NEM Frequency Standard Deviation Half-Hourly Profile

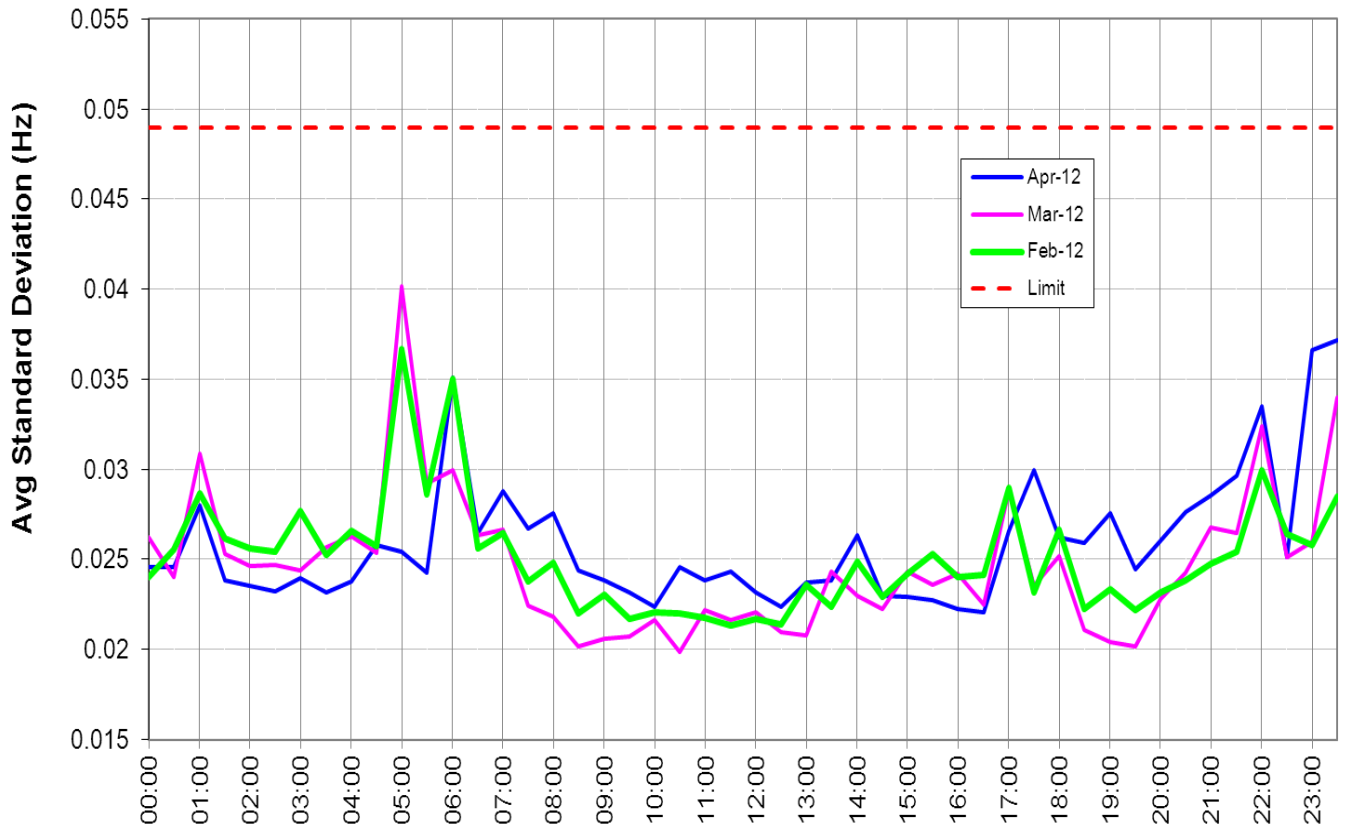


Figure 9: Daily profile of standard deviation for the frequency in the Mainland regions.

Tasmania Frequency Standard Deviation Half-Hourly Profile

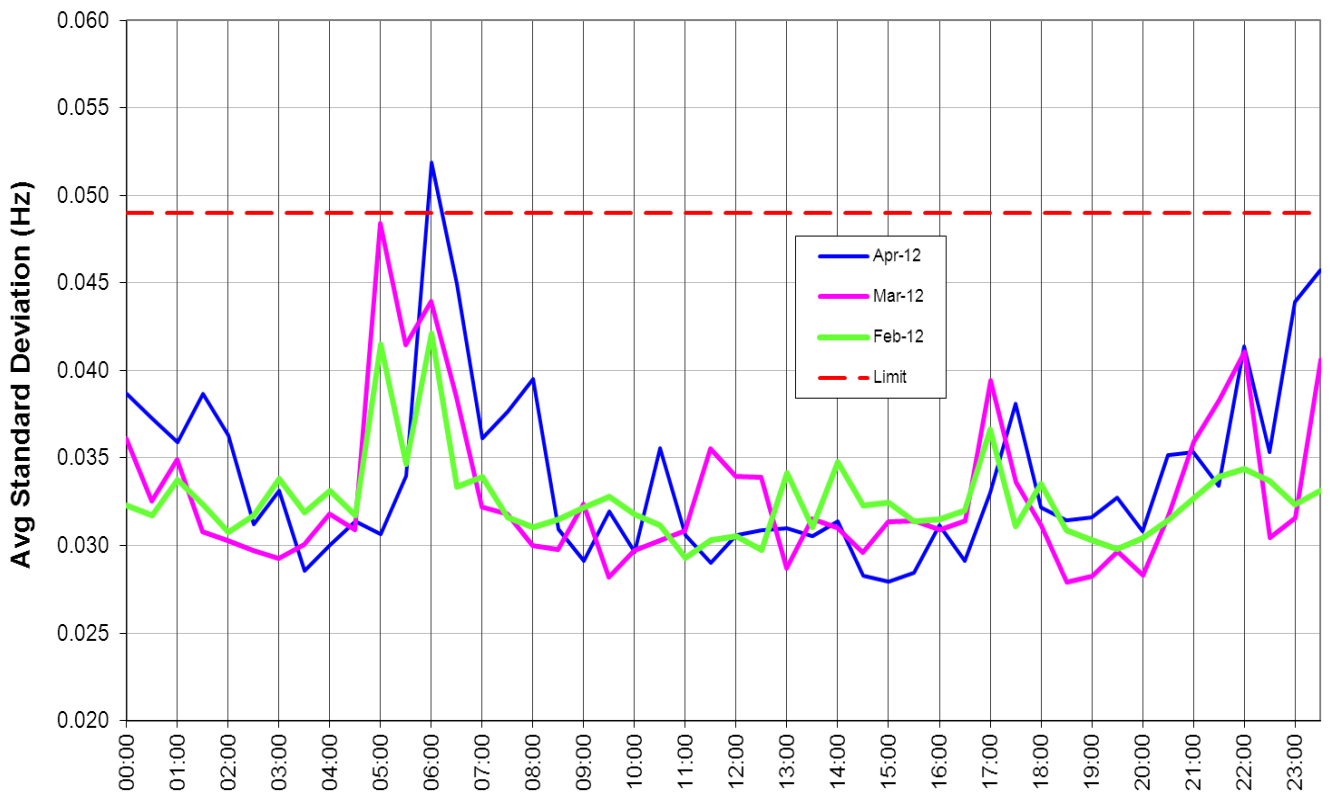


Figure 10: Daily profile of standard deviation for the frequency in Tasmania.

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 April 2012 is provided in Table 3.

Table 3: Accumulated time deviation statistics

	QLD	NSW	VIC	SA	TAS
Maximum Positive Deviation (s)	2.36	2.51	1.54	2.95	10.12
Maximum Negative Deviation (s)	-3.63	-3.52	-4.43	-3.73	-7.45
Mean Value (s)	-0.068	0.016	-0.881	-0.129	-0.595
Standard Dev (s)	0.614	0.613	0.614	0.926	2.301

The distribution of time deviations based on the Mainland regions measurement is provided in Figure 11.

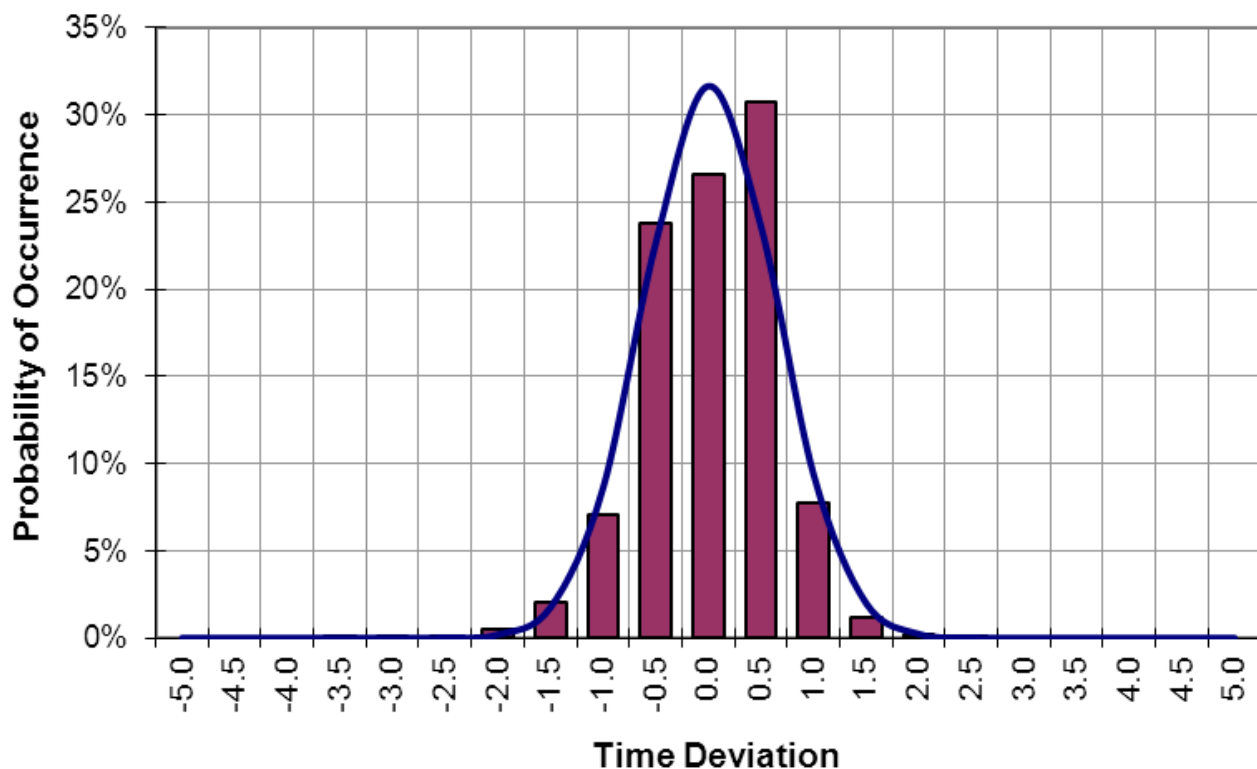


Figure 11: Mainland time deviation distribution for April 2012.

The distribution of time deviations based on the Tasmania region measurement is provided in Figure 12.

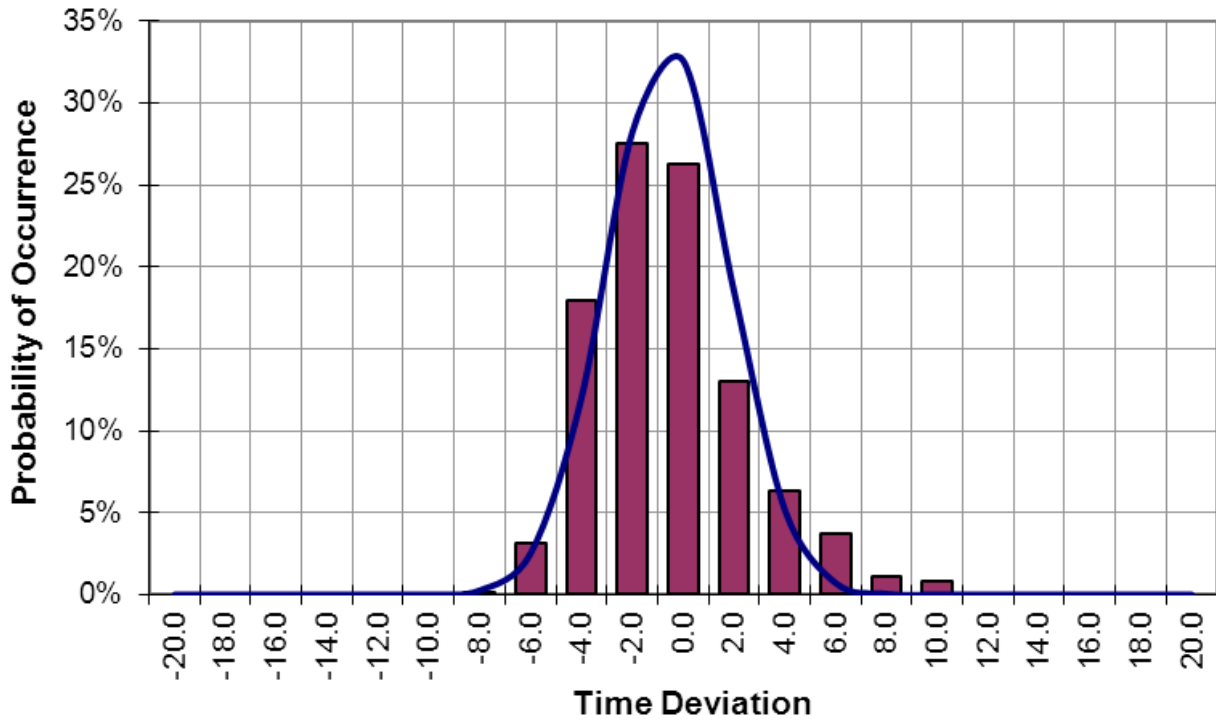


Figure 12: Tasmania time deviation distribution for April 2012.

6.1 Time Error Performance

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

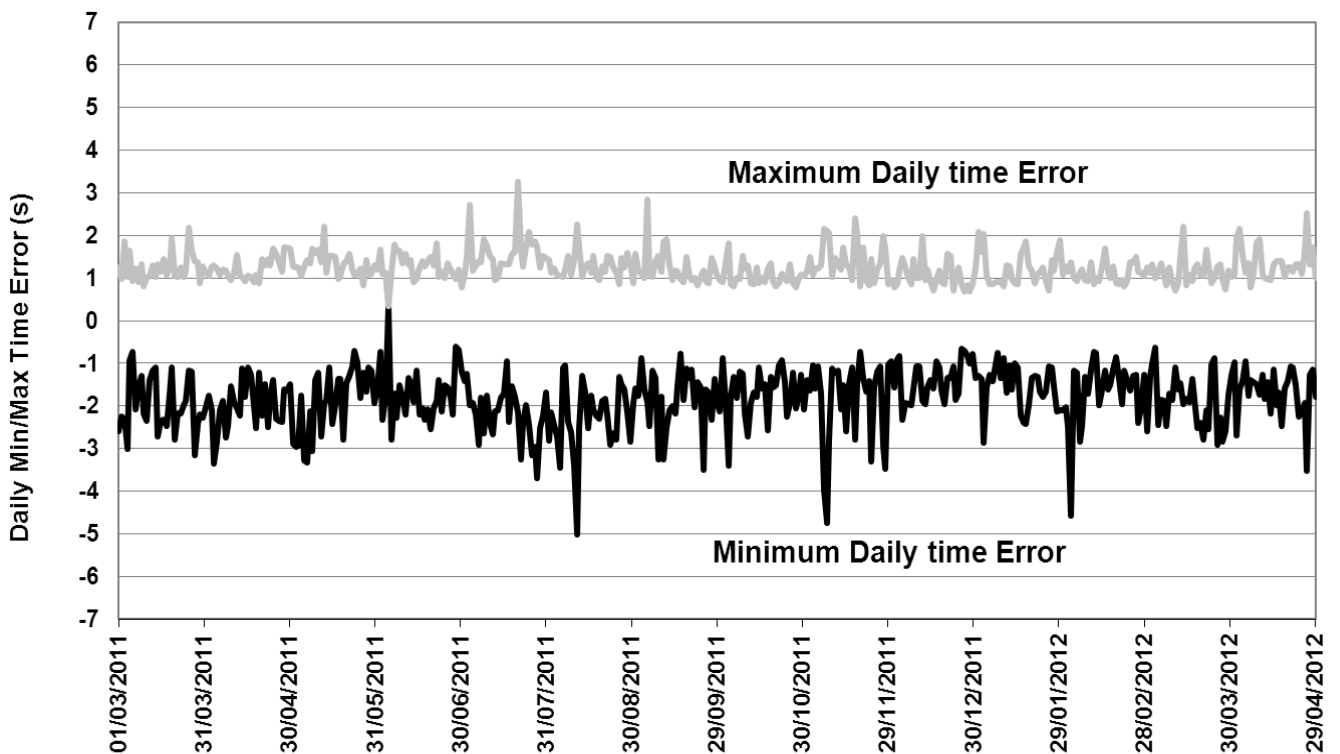


Figure 13: Mainland regions daily maximum and minimum time deviation

Figure 14 presents the daily maximum and minimum values of Tasmania time error observed for the past 13 months.

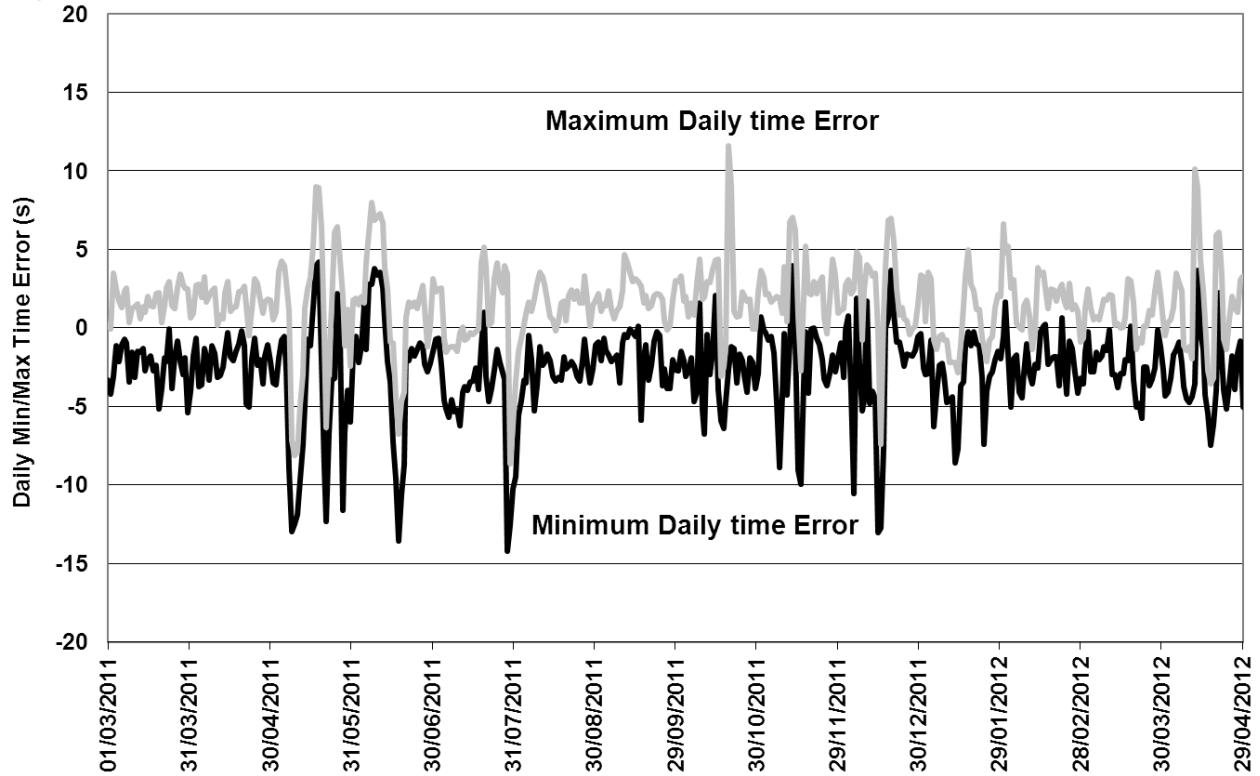


Figure 14: Tasmania daily maximum and minimum time deviation.