

POWER SYSTEM FREQUENCY AND TIME DEVIATION MONITORING

December 2011

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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 December 2011 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 below summarises events in the Mainland and Tasmanian regions for the month December 2011 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 Guidelines 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	25
	HIGH	0	19
Load Event	LOW	0	101
	HIGH	0	164
Generation Event	LOW	0	0
	HIGH	0	0
Network Event	LOW	0	1
	HIGH	0	1
Separation Event	LOW	0	0
	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 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 during December 2011.

4.2 Low Frequency Events in Tasmania

There were three Low Frequency No Contingency events from Table 1 recorded in the Tasmania region during December 2011, that resulted in frequency below the threshold frequency of 49.75 Hz. These events did not meet the Tasmania Frequency Operating Standards and are listed in Table 2 below.

Table 2: Low Frequency No contingency Events in the Tasmania region that did not meet the Tasmania Frequency Operating Standards in December 2011.

DATE	EVENTS	MIN FREQUENCY (HZ)	BELOW 49.85 HZ OR ABOVE 50.15 HZ FOR (SECONDS)
06/12/2011 18:35:04	Basslink non-conformance	49.31	1144 seconds
15/12/2011 16:37:24	Basslink non-conformance	49.42	1280 seconds
15/12/2011 17:17:44	Basslink non-conformance	49.73	220 seconds

4.2.1 Event: 06/12/2011 18:35:04

For the Normal (Non-Contingency) low frequency event on 06th of December 2011 in Tasmania, Figure 1 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 1144 seconds. On 06/12/2011 at 1835 hrs, Basslink targets changed from export (Tasmania to Victoria) to import (Victoria to Tasmania). However, the actual flow on Basslink changed from export to 0 MW but did not follow the import targets. This caused Tasmania frequency to fall to 49.31 Hz and stayed outside the normal operating band for 1144 seconds. In response to this low frequency event, compared to the enabled Slow Raise (R60) and Delayed Raise (R5) FCAS, the FCAS delivered by some units provided a negative response as shown in Figure 2. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. The amount of Fast Raise (R6) services delivered was not calculated since 50 ms data was not requested for the event.

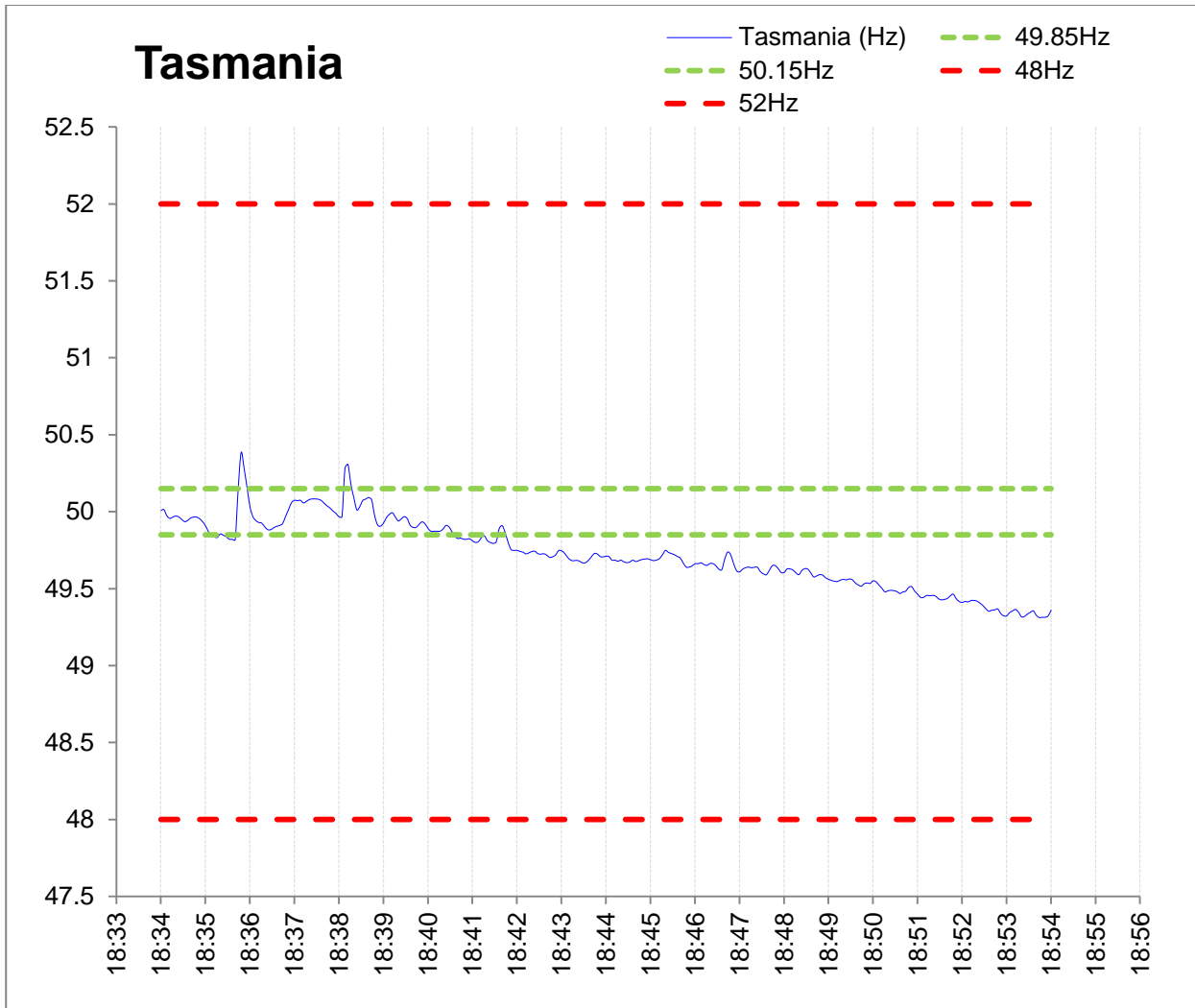


Figure 1: Tasmania frequency during Low frequency No contingency event in Table 2 on 06th December 2011.

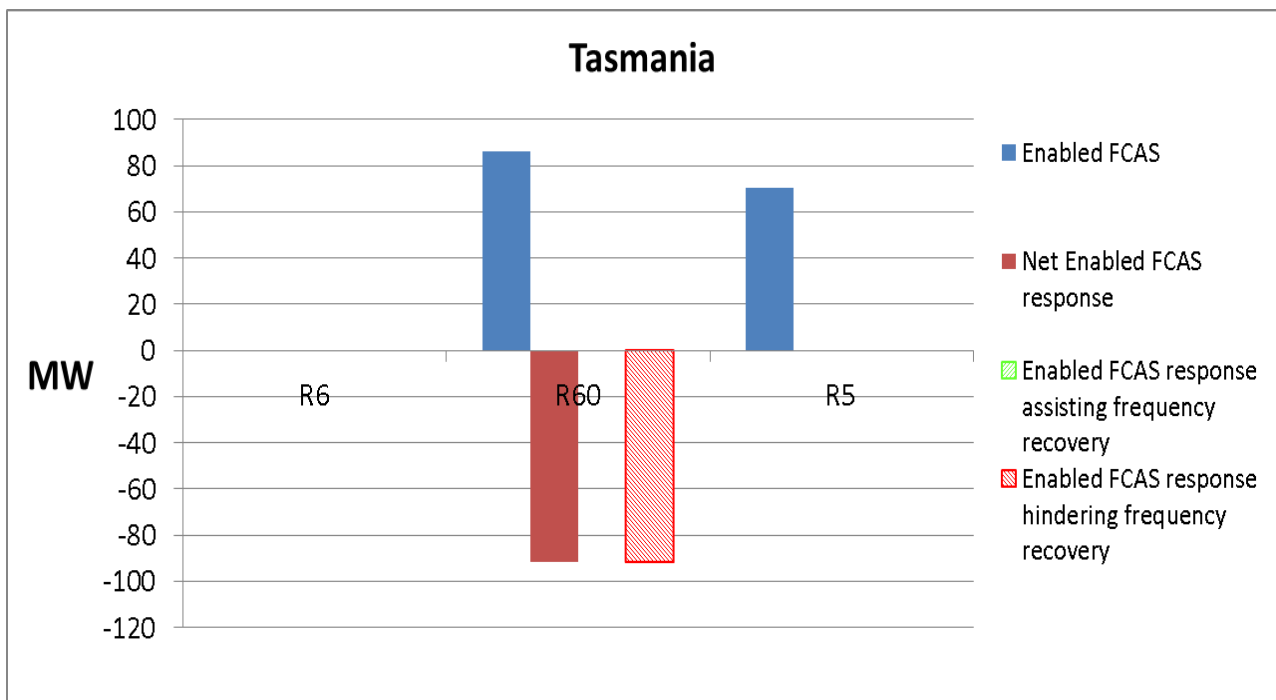


Figure 2: FCAS response during Low frequency No contingency event in Table 2 on 06th December 2011.

4.2.2 Event: 15/12/2011 16:37:24

For the Normal (Non-Contingency) low frequency event on 15th of December 2011 at 1637 hrs, Figure 3 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 1280 seconds. On 15/12/2011 at 1630 hrs, Basslink targets changed from export (Tasmania to Victoria) to import (Victoria to Tasmania). However, the actual flow on Basslink changed from export to 45 MW but did not follow the import targets. This caused Tasmania frequency to fall to 49.42 Hz. In response to this low frequency event, compared to the enabled Slow Raise (R60) and Delayed Raise (R5) FCAS, only a fraction was delivered by some units providing a negative response as shown in Figure 4. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. The amount of Fast Raise (R6) services delivered was not calculated since 50 ms data was not requested for the event.

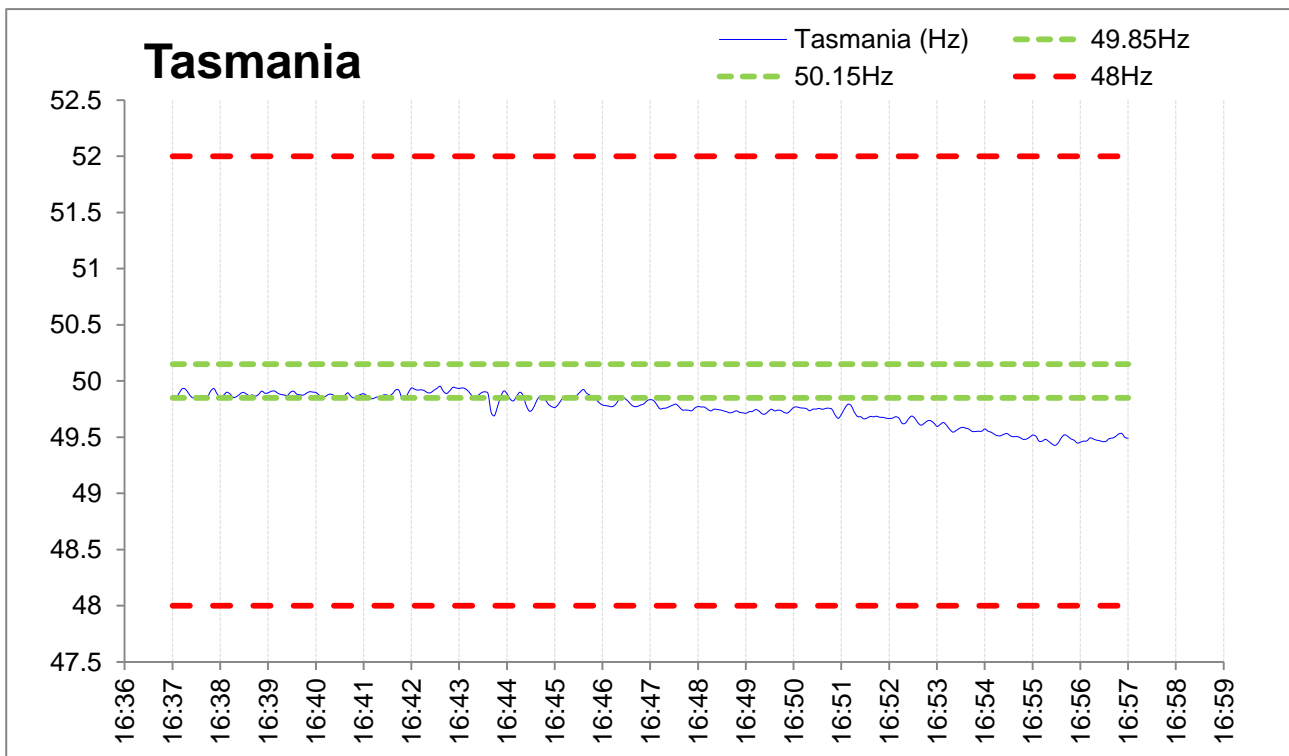


Figure 3: Tasmania frequency during Low Frequency No contingency event in Table 2 on 15th December 2011 at 1637 hrs.

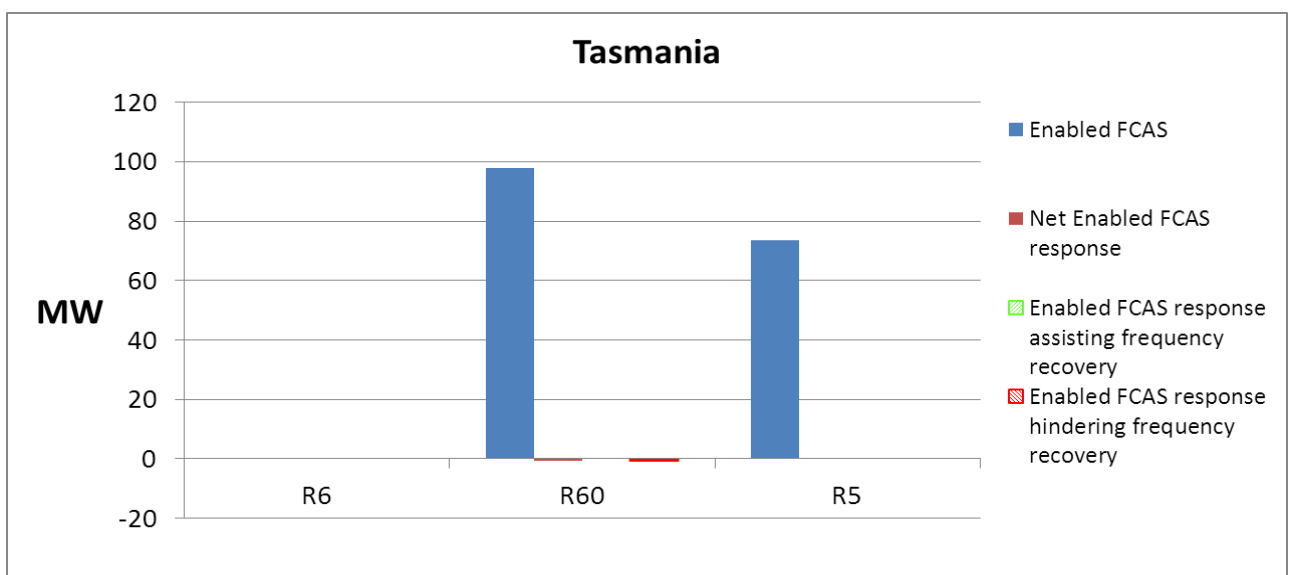


Figure 4: FCAS response during Low frequency No contingency event on 15th December 2011 at 1637 hrs.

4.2.3 Event: 15/12/2011 17:17:44

For the Normal (Non-Contingency) low frequency event on 15th of December 2011 at 1717 hrs, Figure 5 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 220 seconds. On 15/12/2011 at 1715 hrs, Basslink targets transitioned from export (Tasmania to Victoria) to import (Victoria to Tasmania). However, the actual flow on Basslink transitioned from export to 45 MW but did not follow the import targets. This caused Tasmania frequency to fall to 49.73 Hz. In response to this low frequency event, compared to the enabled Slow Raise (R60) and Delayed Raise (R5) FCAS, the FCAS delivered by some units provided a negative response is shown in Figure 6. The frequency excursion was not sufficient to trigger switched controllers to deliver delayed FCAS during the event. The amount of Fast Raise (R6) services delivered was not calculated since 50 ms data was not requested for the event.

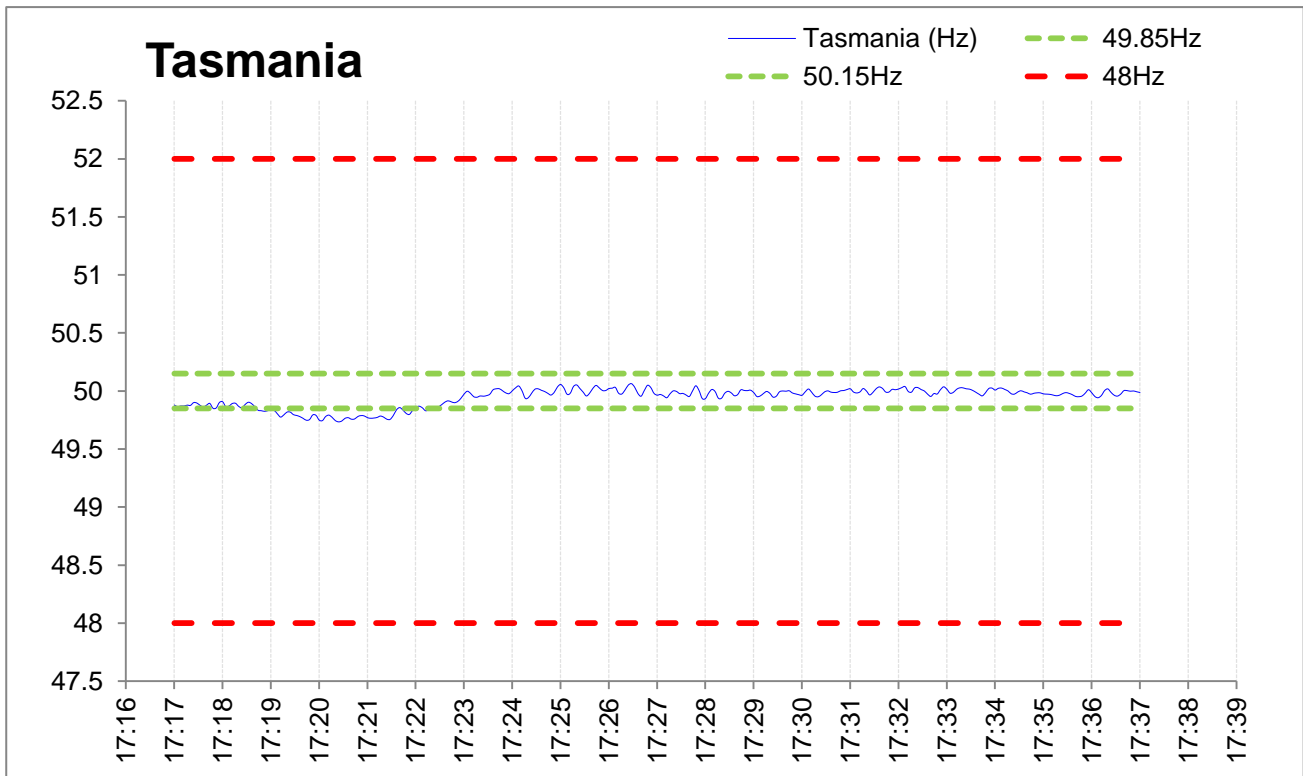


Figure 5: Tasmania frequency during Low Frequency No contingency event in Table 2 on 15th December 2011 at 1717 hrs.

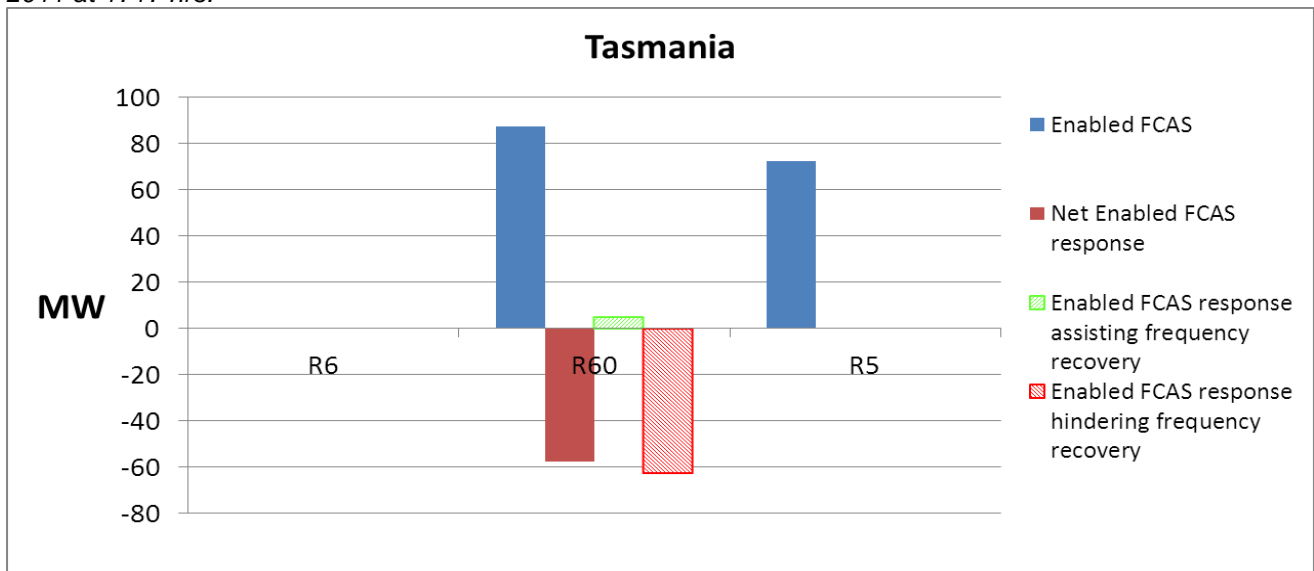


Figure 6: FCAS response during Low frequency No contingency event on 15th December 2011 at 1717 hrs.

5 Statistical analysis

With exception of major power system disturbances which are excluded, the frequency distribution for the Mainland and Tasmanian regions were within the frequency operating standards in the month of December 2011.

Frequency in the Mainland regions was within the range 49.92 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 December 2011 was 50 Hz with a standard deviation of 0.028 Hz.

Frequency in the Tasmania region was within the range 49.91 – 50.09 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 Hz for 99.94% of the time. The frequency was outside the range 49.75 Hz – 50.25 Hz for 0.06% of the time. The mean value of frequency during December 2011 was 50 Hz with a standard deviation of 0.038 Hz.

5.1.1 Daily frequency standard deviation

Figure 7 and Figure 8 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.

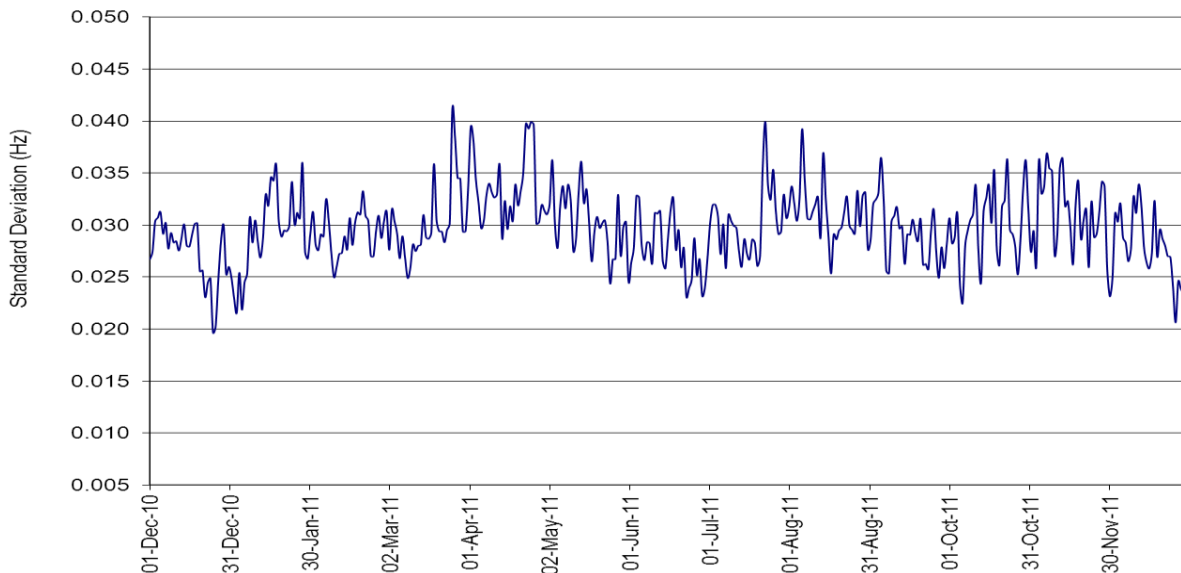


Figure 7: Daily standard deviation of Mainland frequency

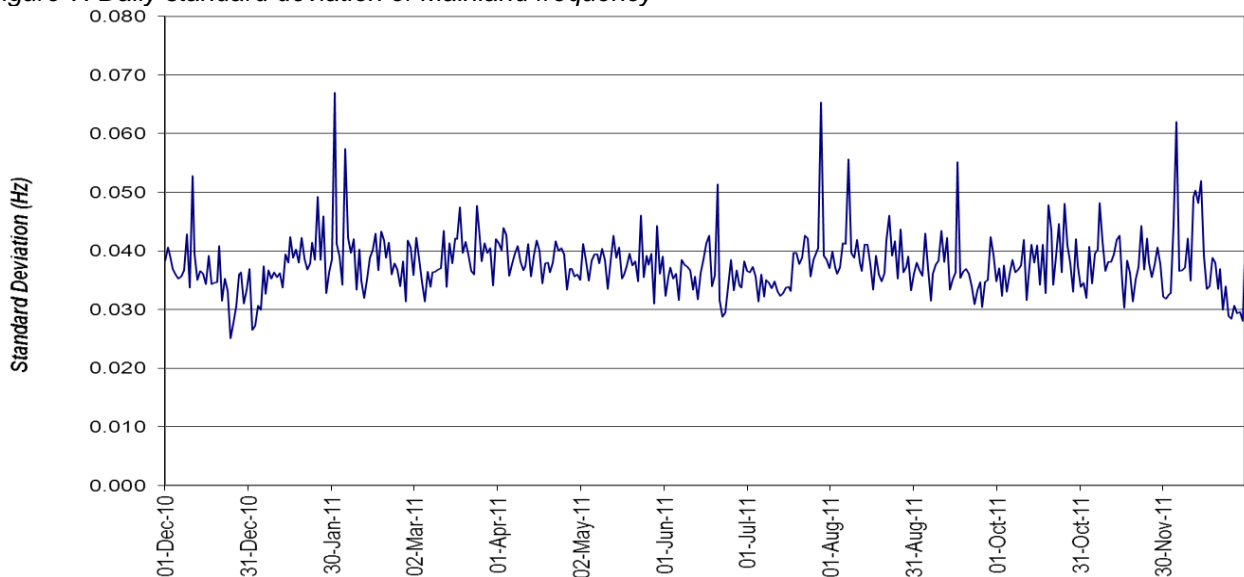


Figure 8: Daily standard deviation of frequency in Tasmania

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 October, November and December 2011. 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).

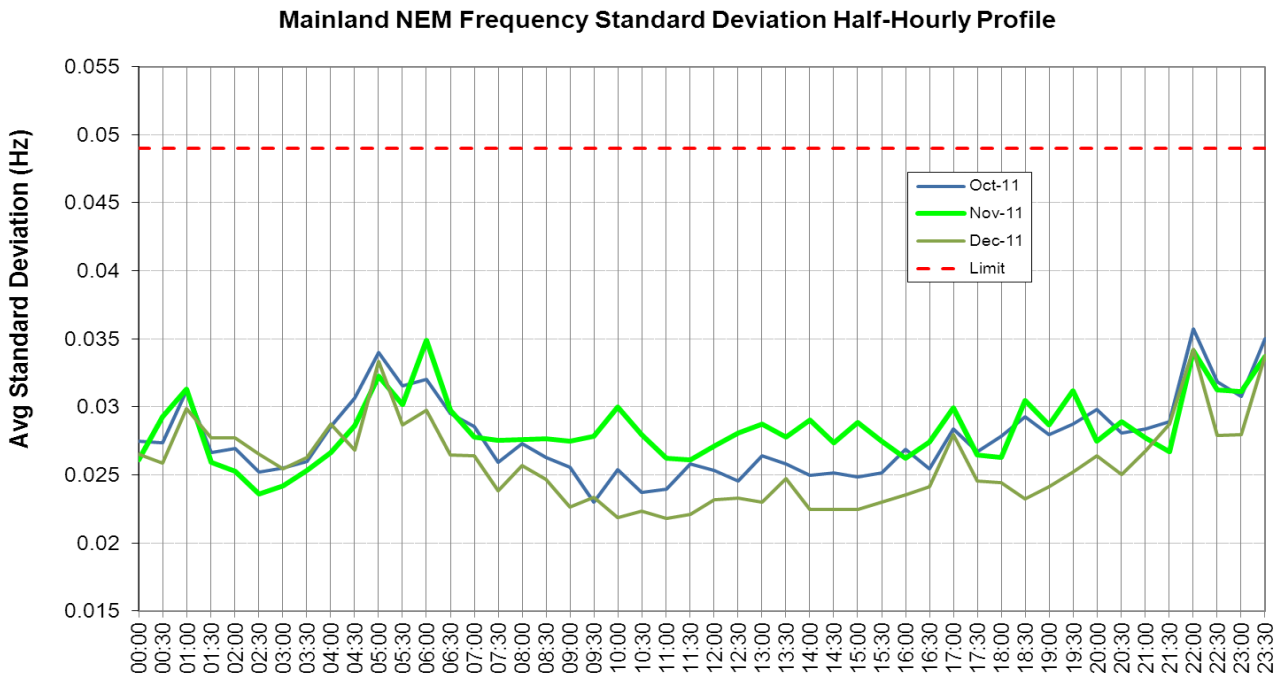


Figure 9: Daily profile of standard deviation for the frequency in the Mainland regions

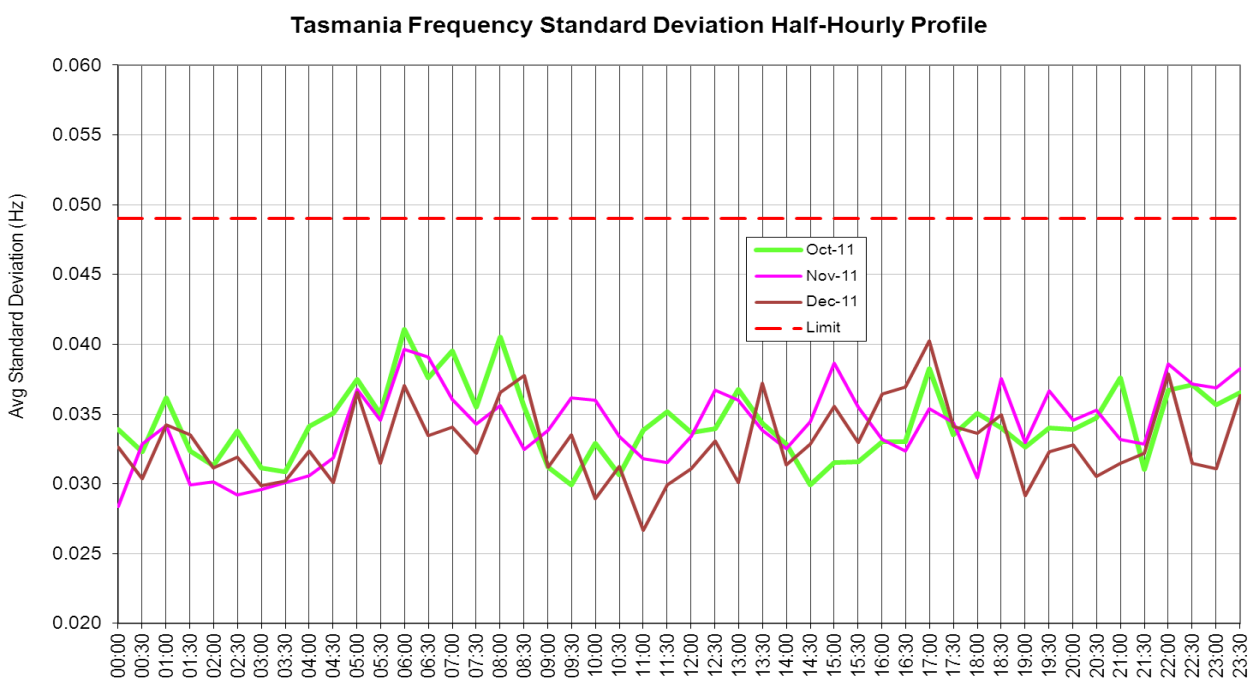


Figure 10: Daily profile of standard deviation for the frequency in Tasmania

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 December 2011 is provided in Table 3.

Table 3: Accumulated time deviation statistics

	QUEENSLAND	NSW	VIC	SA	TAS
Maximum Positive Deviation (s)	1.87	1.99	1.54	1.28	6.96
Maximum Negative Deviation (s)	-2.39	-2.31	-2.42	-2.99	-13.03
Mean Value (s)	-0.075	0.053	-0.295	-0.667	-0.184
Standard Dev (s)	0.508	0.507	0.540	0.508	3.244

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

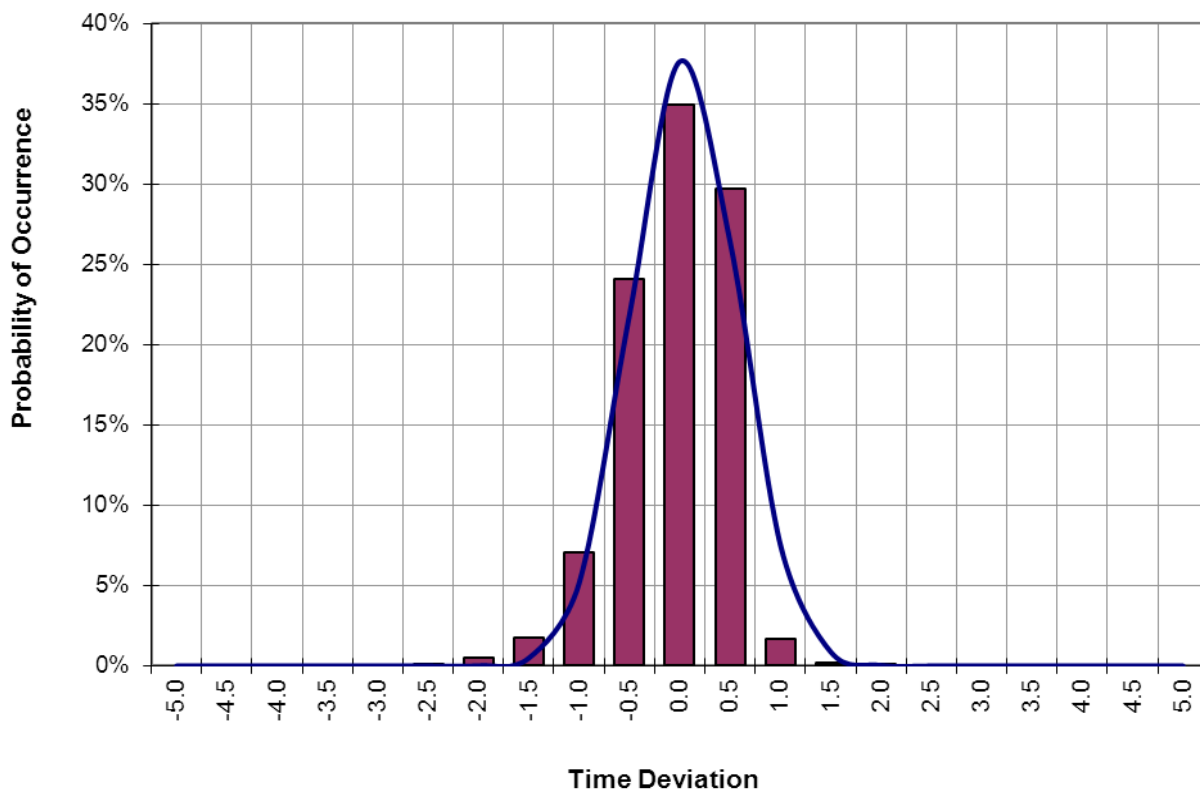


Figure 11: Mainland time deviation distribution for December 2011

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

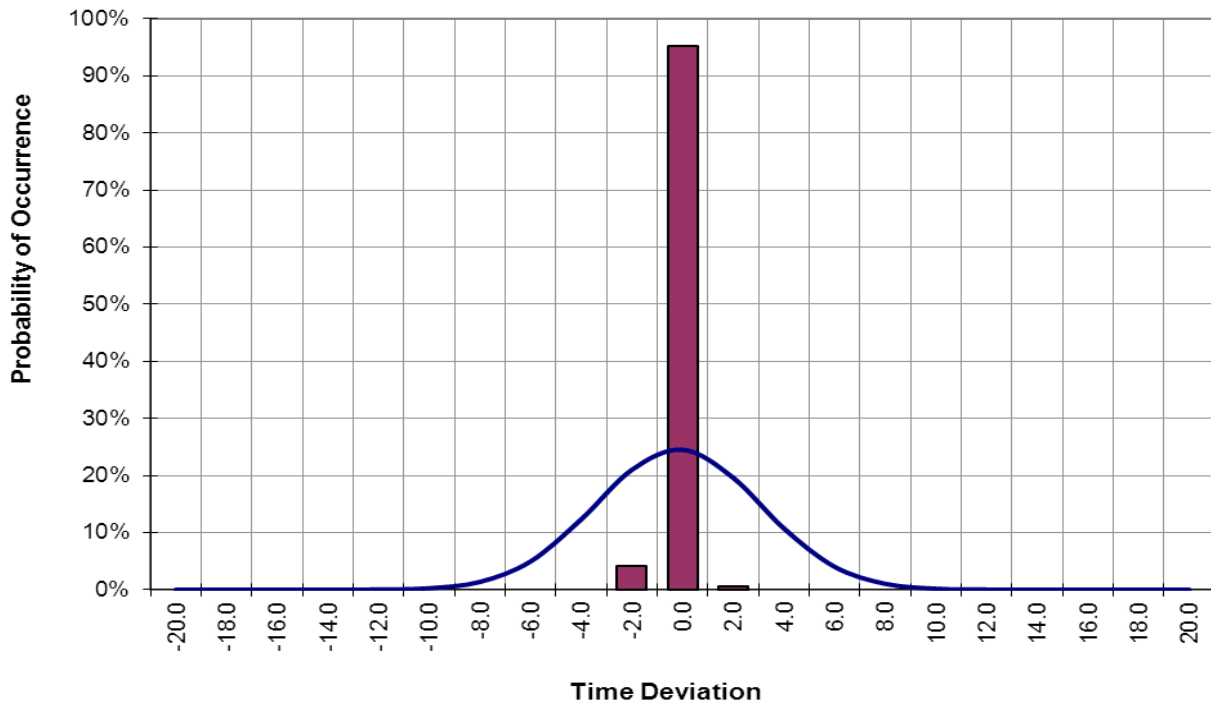


Figure 12: Tasmania time deviation distribution for December 2011

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.

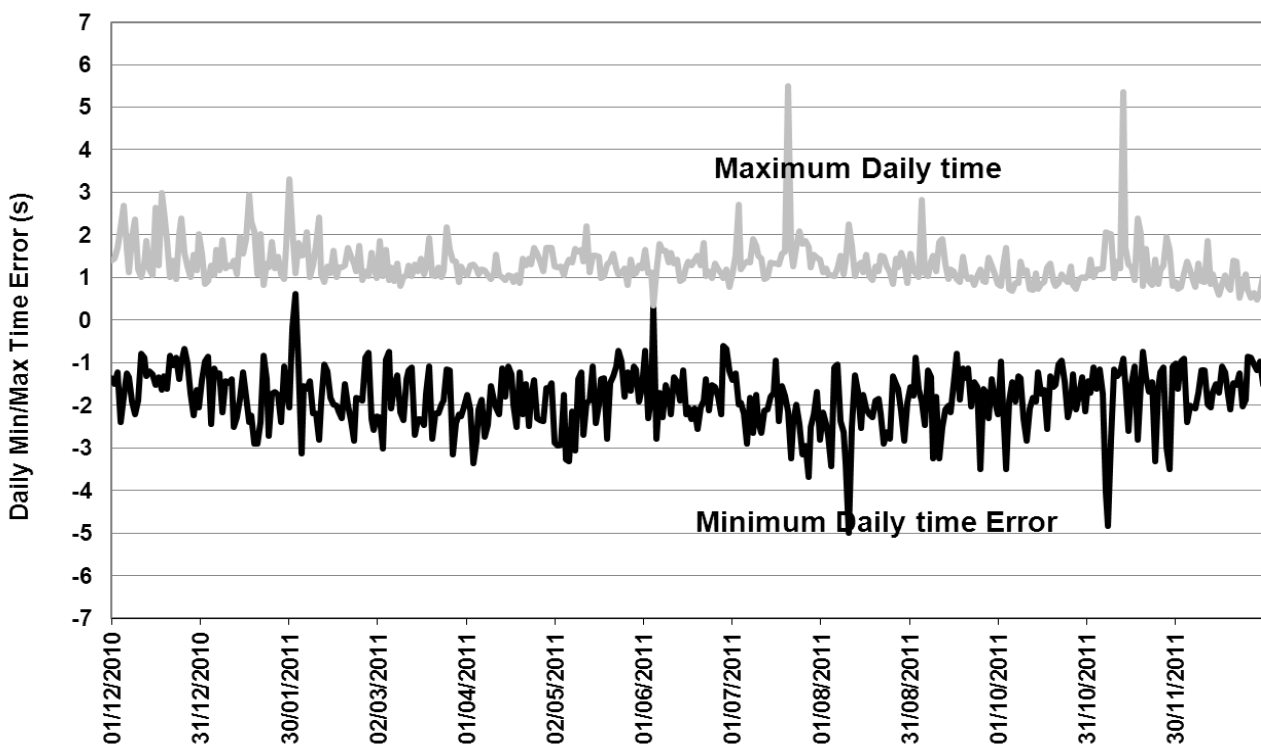


Figure 13: Mainland regions daily maximum and minimum time deviation

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

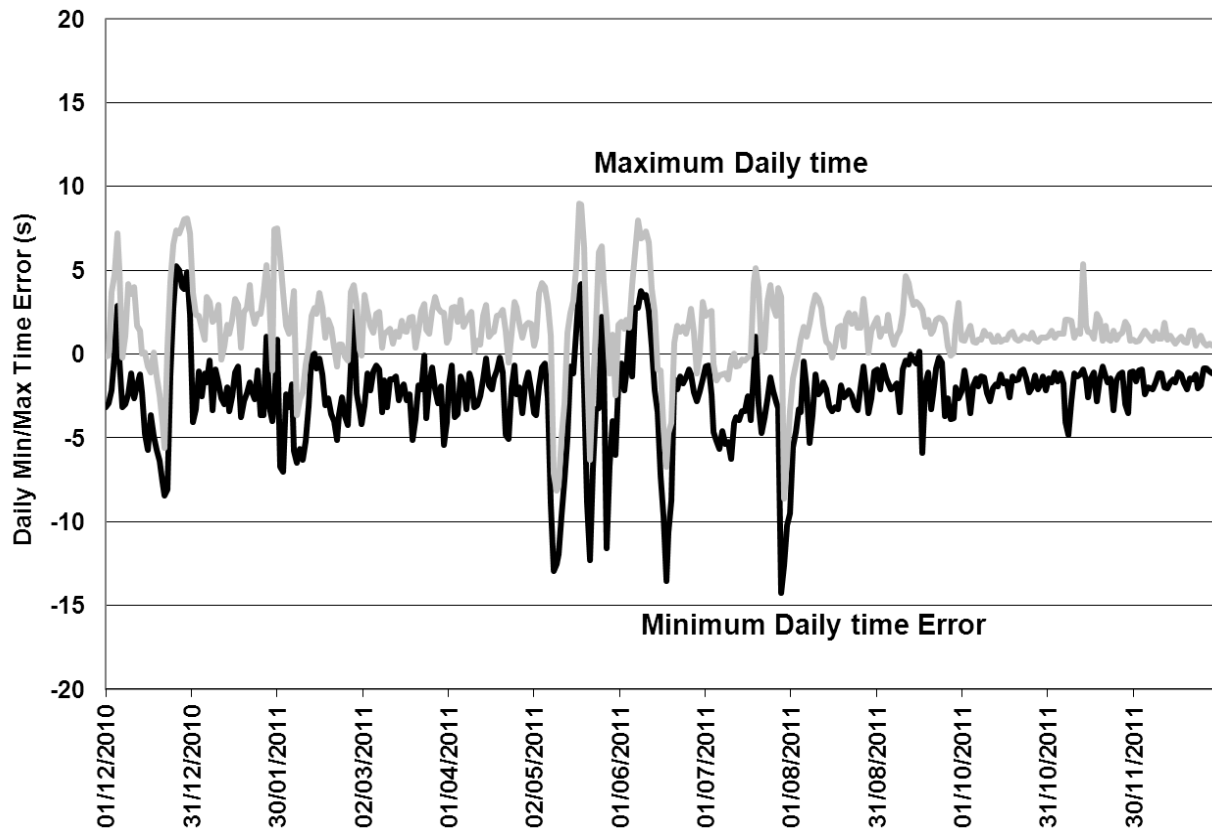


Figure 14: Tasmania daily maximum and minimum time deviation