

POWER SYSTEM FREQUENCY AND TIME DEVIATION MONITORING

June 2011

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1.0	14/06/2012	HSingh	Original Report
2.0	20/07/2012	HSingh	Section 4 updated with four additional events that are now identified as not meeting the Frequency Operating Standards

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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 June 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 June 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	40
	HIGH	0	11
Load Event	LOW	0	76
	HIGH	0	142
Generation Event	LOW	2	4
	HIGH	0	1
Network Event	LOW	0	0
	HIGH	0	0
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 Regions

There were no events recorded in Mainland Regions that did not meet the mainland frequency operating standards from those identified in Table 1 during June 2011.

4.2 Low Frequency Events in Tasmania Region

There were four Low Frequency Normal Condition Events from Table 1 recorded in the Tasmania Region during June 2011 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 1: Low Frequency Normal Condition Events (No Contingency) in the Tasmania region that did not meet the Tasmania Frequency Operating Standards in June 2011.

DATE	EVENT	MIN FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)
04/06/2011 16:10:40	No condition causing the event was identified.	49.72	20
15/06/2011 03:26:44	No condition causing the event was identified.	49.62	60
18/06/2011 01:45:08	No condition causing the event was identified.	49.74	16
18/06/2011 03:11:04	No condition causing the event was identified.	49.32	44

4.2.1 Event: 04/06/2011 16:10:40

For the Normal (Non-Contingency) low frequency event on 4th June 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 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 2. 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 49.72 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.

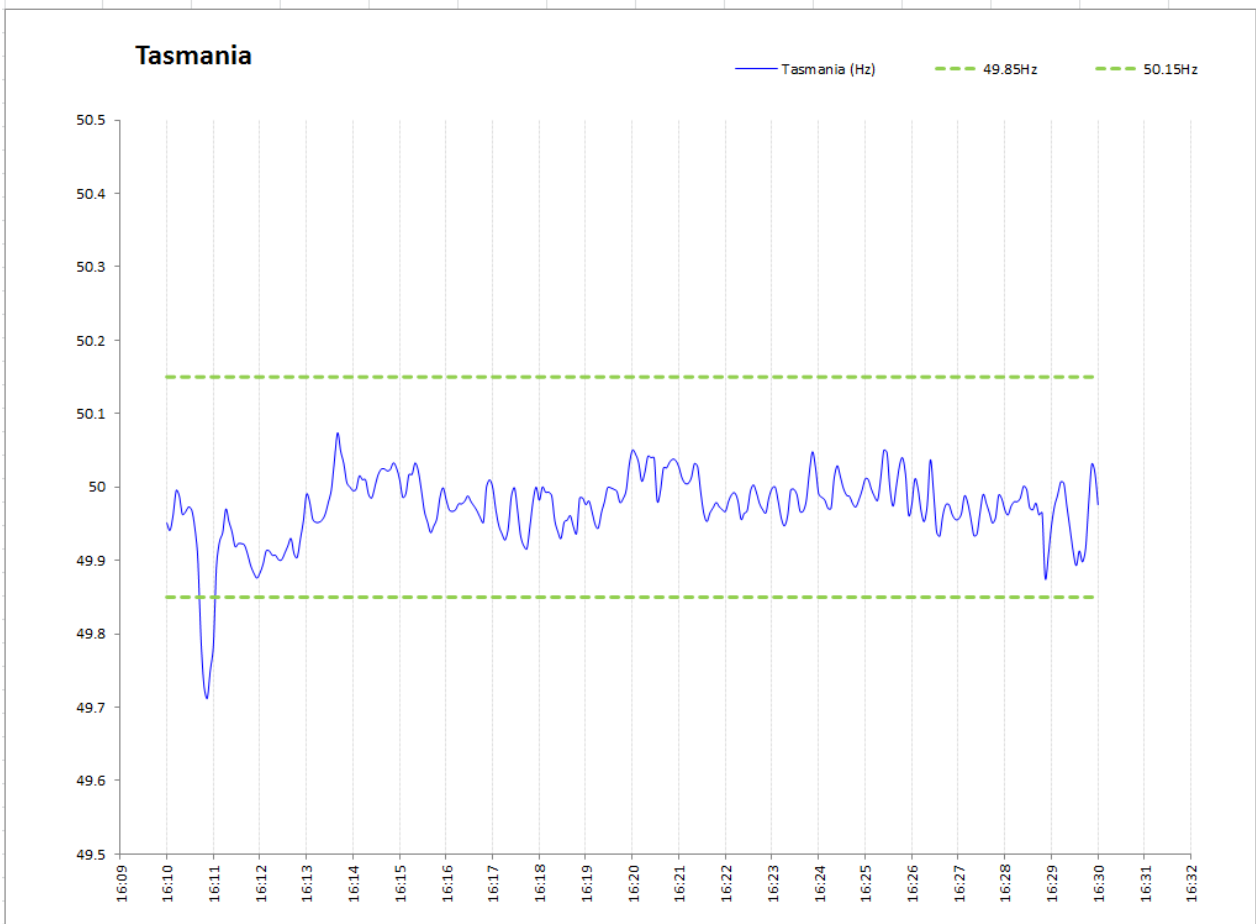


Figure 1: Low Frequency Normal Event in Tasmania refer to item 1 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard

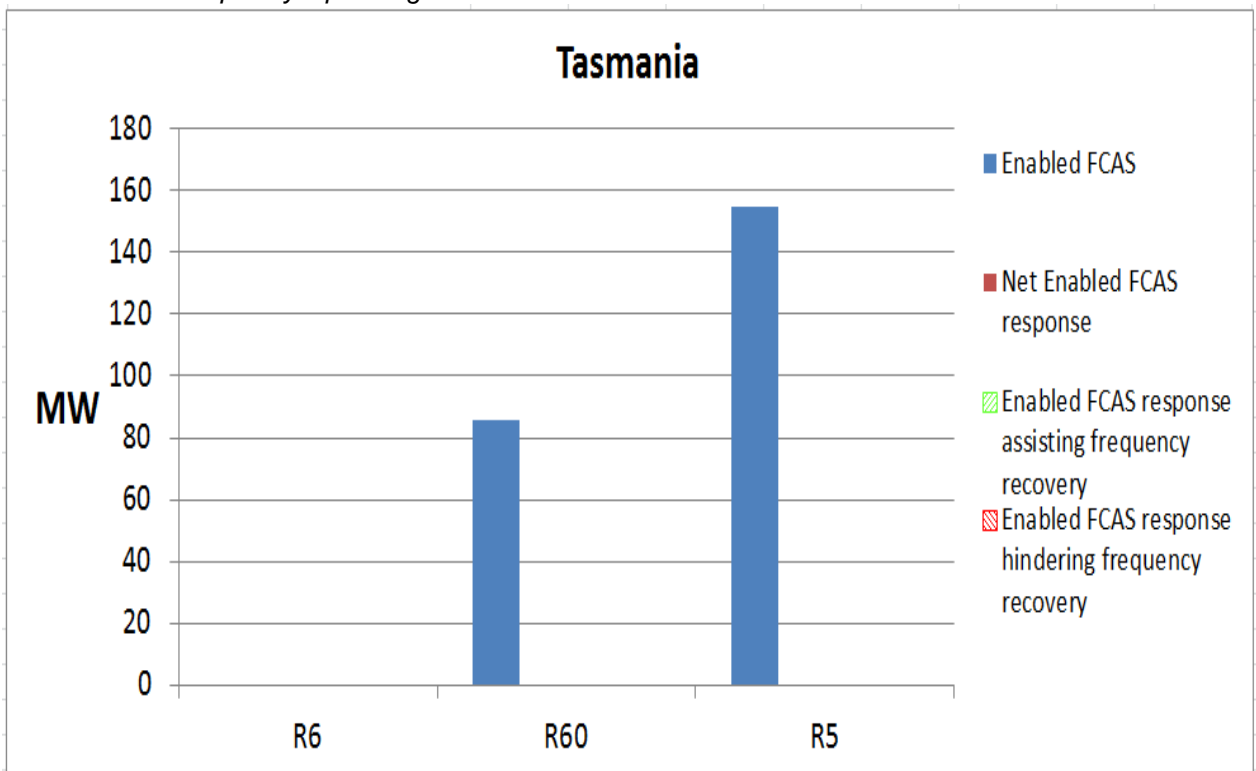


Figure 2: FCAS response to Normal (Non-Contingency) Low Frequency Event on 4th June 2011.

4.2.2 Event: 15/06/2011 03:26:44

For the Normal (Non-Contingency) low frequency event on 15th June 2011 in Tasmania, Figure 3 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 60 seconds. Two Tasmanian generating units ramped down from 10 MW to zero MW each following their respective generation targets which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, only a fraction was delivered with some units providing a negative response as shown in Figure 4. The flow across Basslink was approximately 473 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not transport 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.

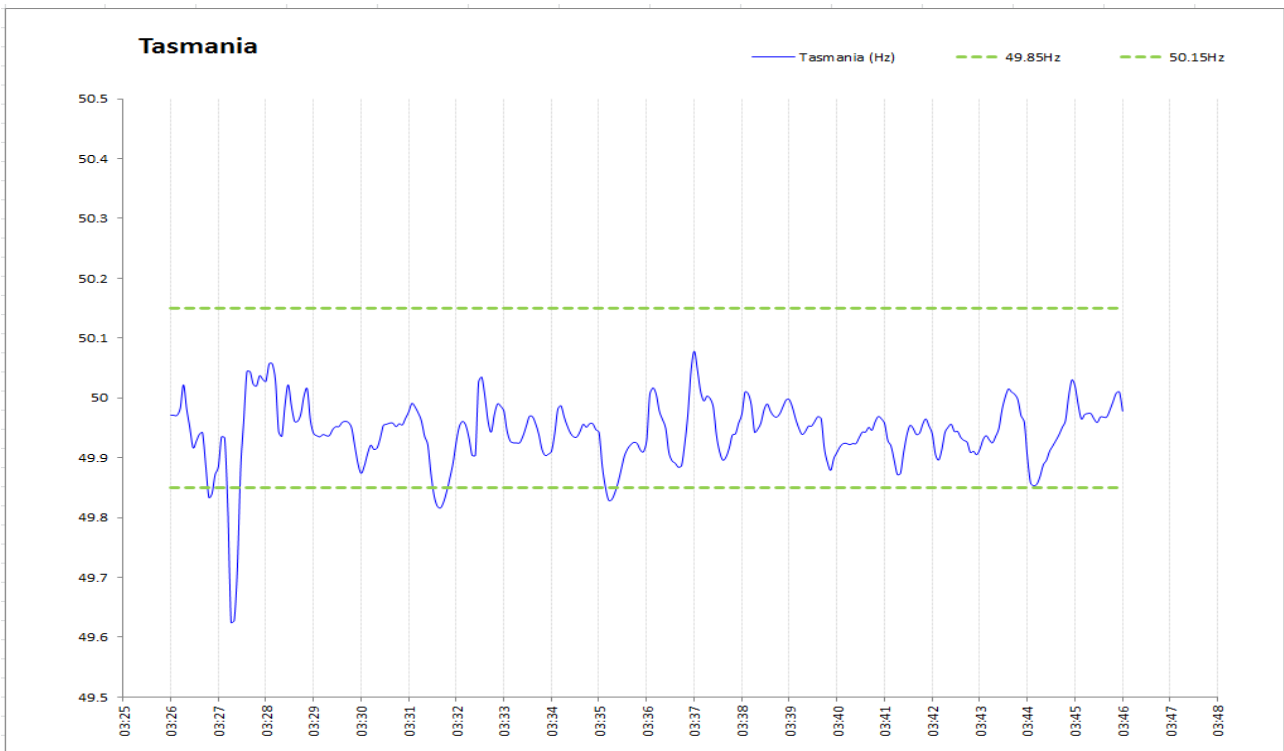


Figure 3: Low Frequency Normal Event in Tasmania refer to item 2 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard

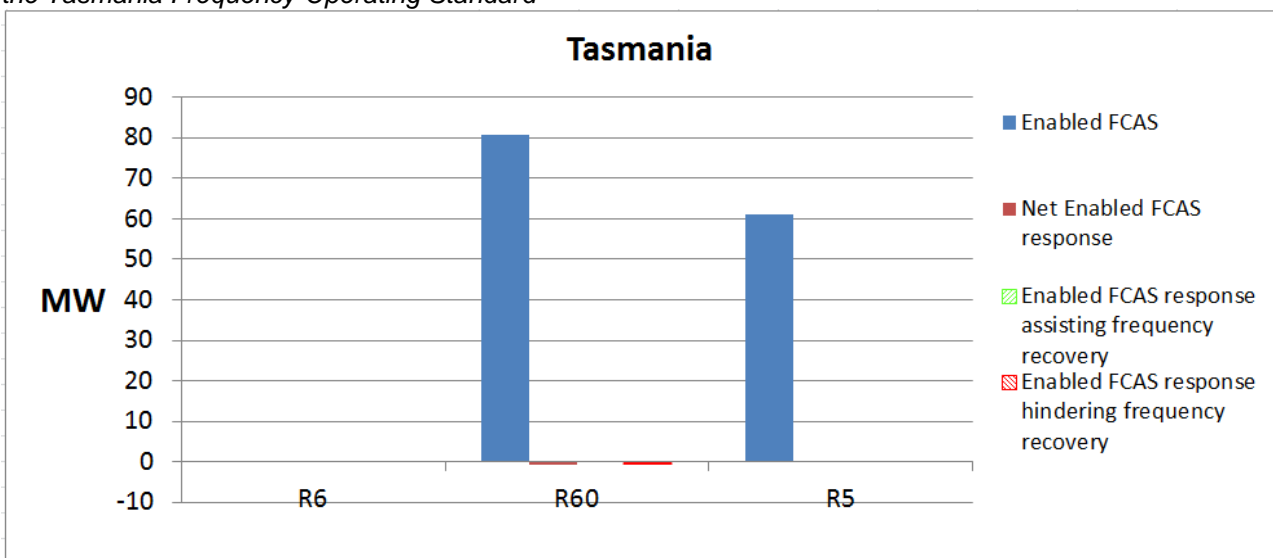


Figure 4: FCAS response to Normal (Non-Contingency) Low Frequency Event on 15th June 2011.

4.2.3 Event: 18/06/2011 01:45:08

For the Normal (Non-Contingency) low frequency event on 18th June 2011 in Tasmania, Figure 5 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 16 seconds. One Tasmanian generating unit ramped down to follow its respective generation target which contributed to the frequency excursion. Compared to the enabled slow raise and delayed raise FCAS, only a fraction was delivered with some units providing a negative response as shown in Figure 6. The flow across Basslink was approximately 476 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.

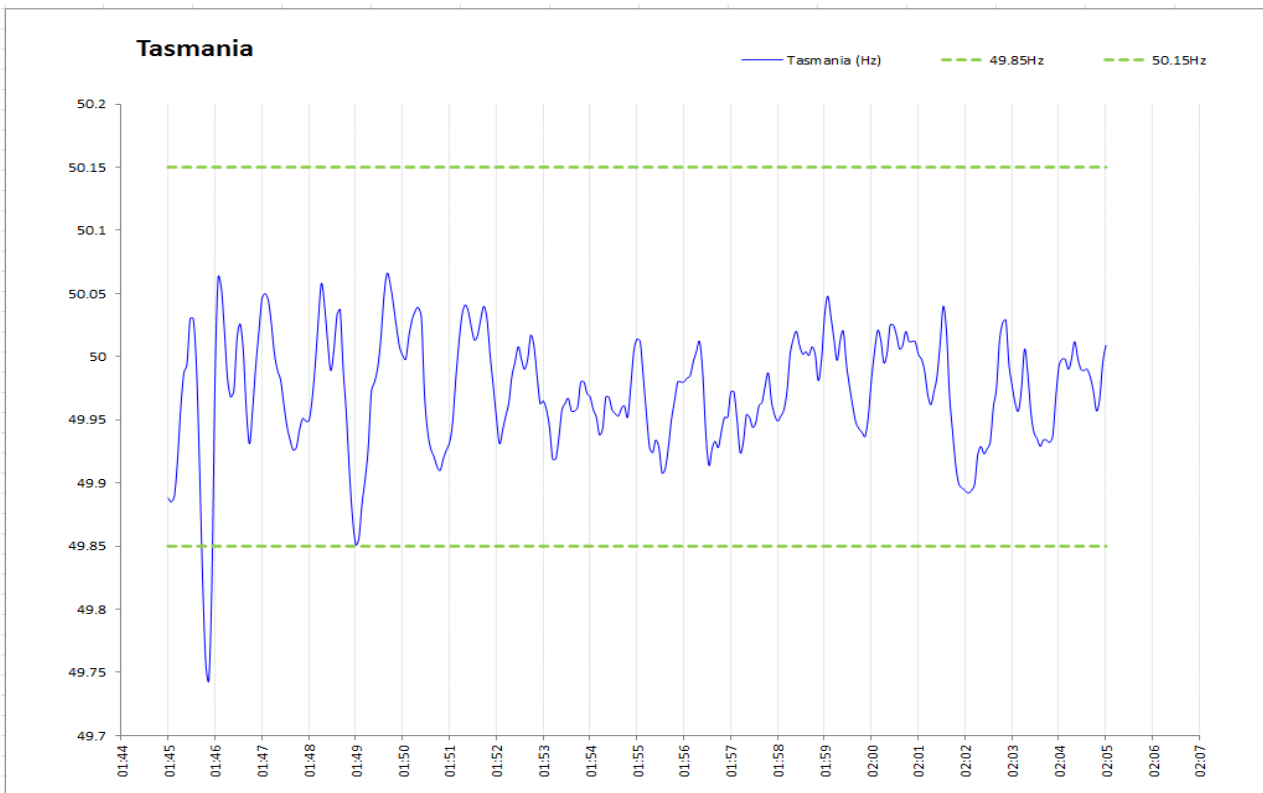


Figure 5: Low Frequency Normal Event in Tasmania refer to item 3 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard

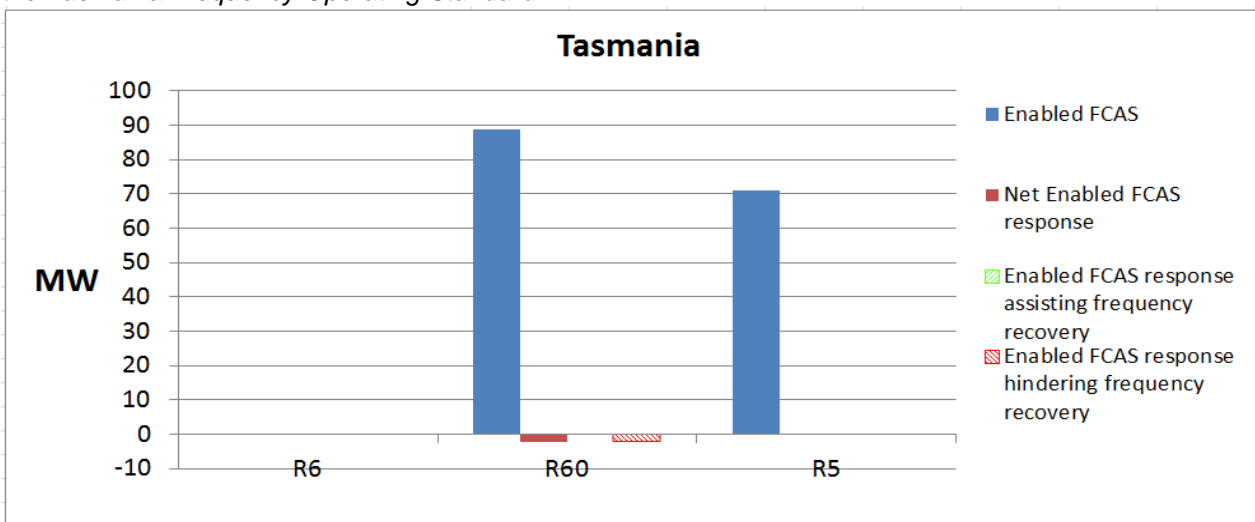


Figure 6: FCAS response to Normal (Non-Contingency) Low Frequency Event on 18th June 2011.

4.2.4 Event: 18/06/2011 03:11:04

For the Normal (Non-Contingency) low frequency event on 18th June 2011 in Tasmania, Figure 7 shows that the Tasmania region frequency exceeded the Tasmania Frequency Operating Standards and was outside the normal operating band for 44 seconds. The sudden increase in Tasmanian total load demand by 5 MW ~ 10 MW increments contributed to the frequency excursion although Tasmanian generation also increased in response to the total demand. Compared to the enabled slow raise and delayed raise FCAS, only a fraction was delivered with some units providing a negative response as shown in Figure 8. The flow across Basslink was approximately 474 MW towards Tasmania during the time of the frequency excursion. Basslink frequency controller did not transport 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 49.32 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.

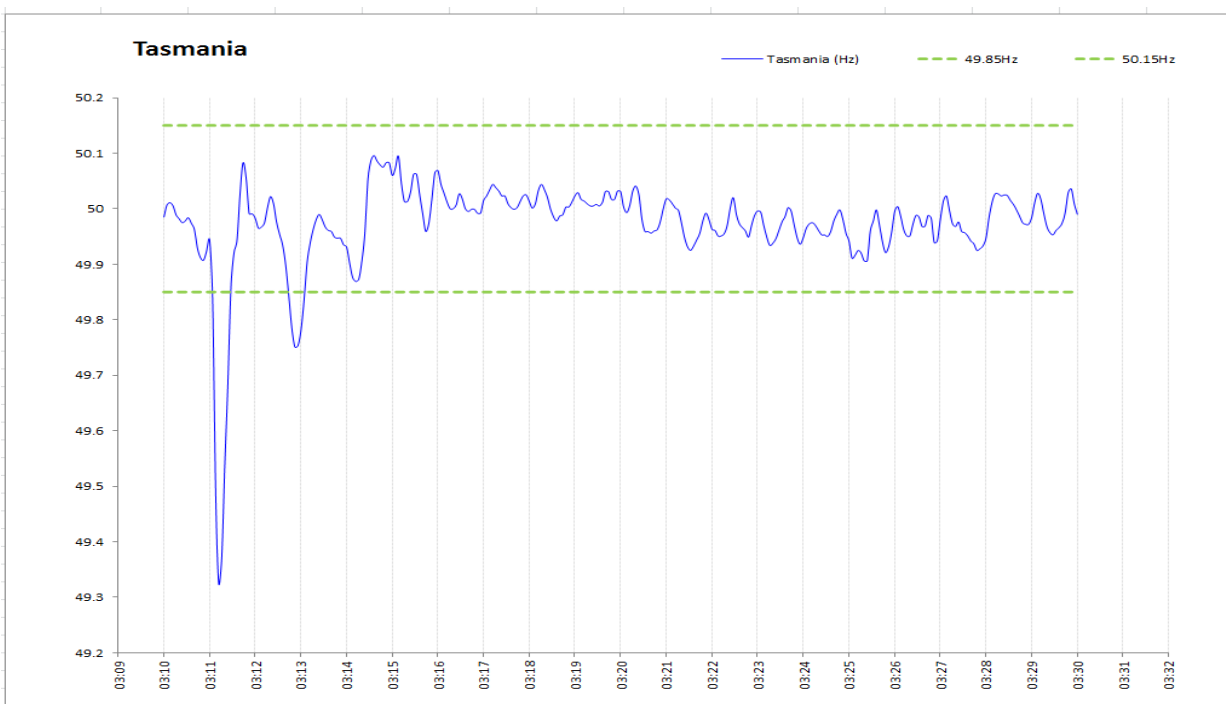


Figure 7: Low Frequency Normal Event in Tasmania refer to item 4 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard

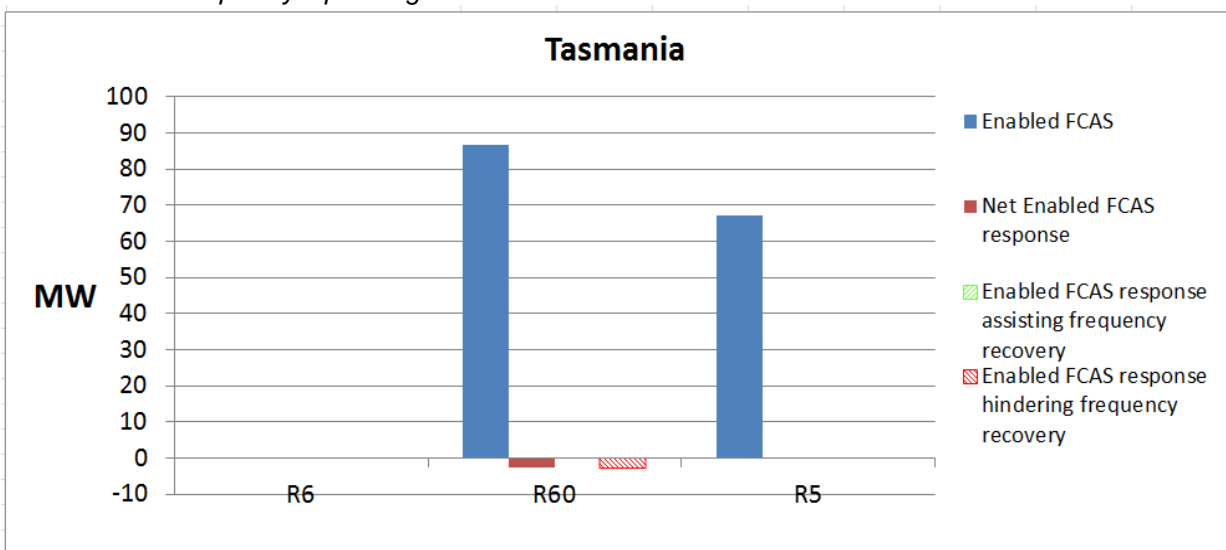


Figure 8: FCAS response to Normal (Non-Contingency) Low Frequency Event on 18th June 2011.

5 Statistical analysis

With the 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 June 2011.

Frequency in the mainland regions was within the range 49.92 Hz – 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 June 2011 was 50 Hz with a standard deviation of 0.028 Hz.

Frequency in the Tasmania region was within the range 49.91 Hz – 50.09 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 June 2011 was 50 Hz with a standard deviation of 0.036 Hz.

5.1.1 Daily Frequency Standard Deviation

Figure 9 and Figure 10 below plot the daily standard deviation of the Mainland and Tasmanian frequency for the past 13 months. With exception of major power system disturbances, which are excluded, the frequency standard deviation shown in Figure 9 and Figure 10 do not exclude load and contingency events.

Daily standard deviation of frequency in Mainland for the past 13 months is shown in Figure 9 below.

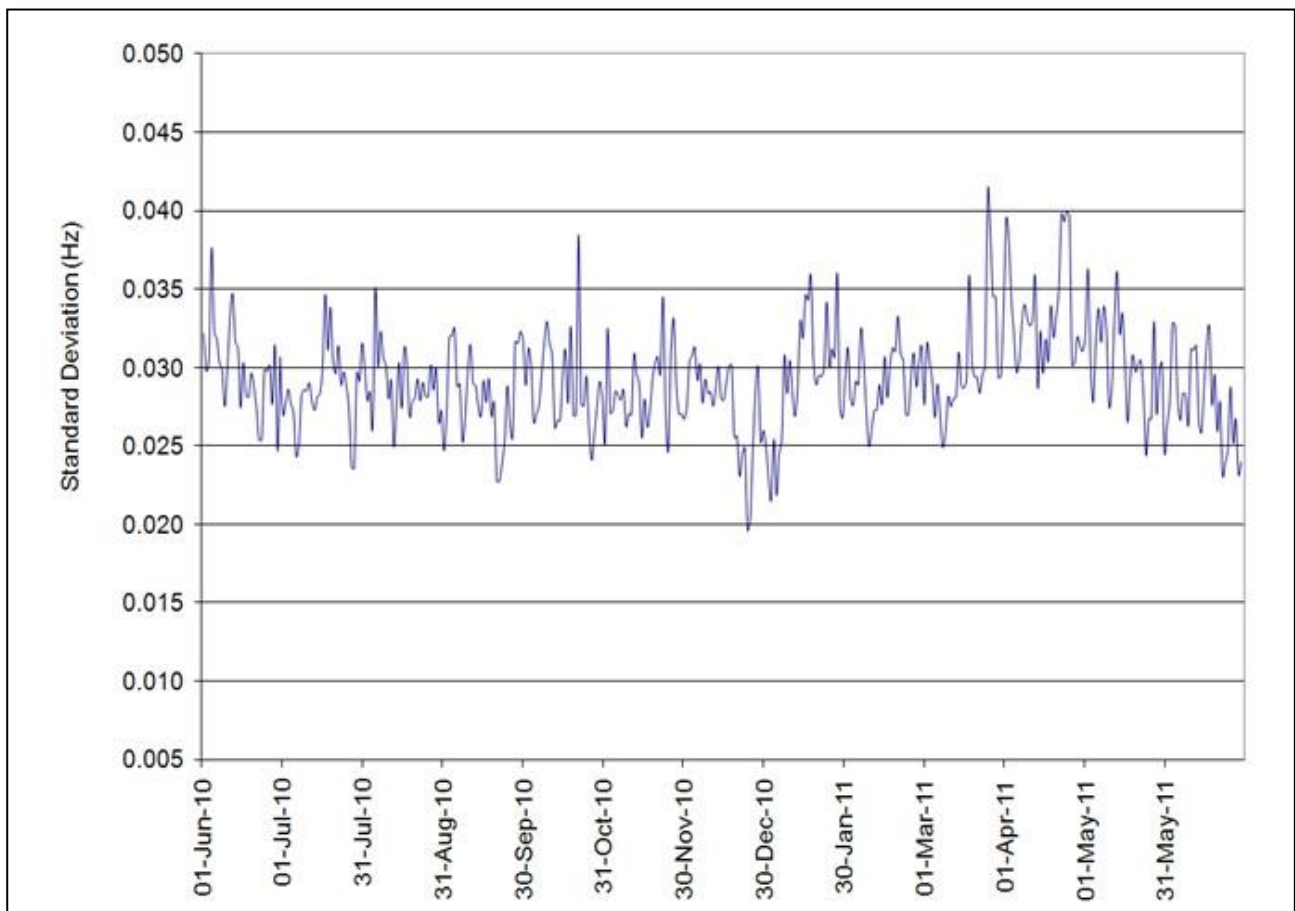


Figure 9: Daily standard deviation of frequency in Mainland

Daily standard deviation of frequency in Tasmania for the past 13 months is shown in Figure 10 below.

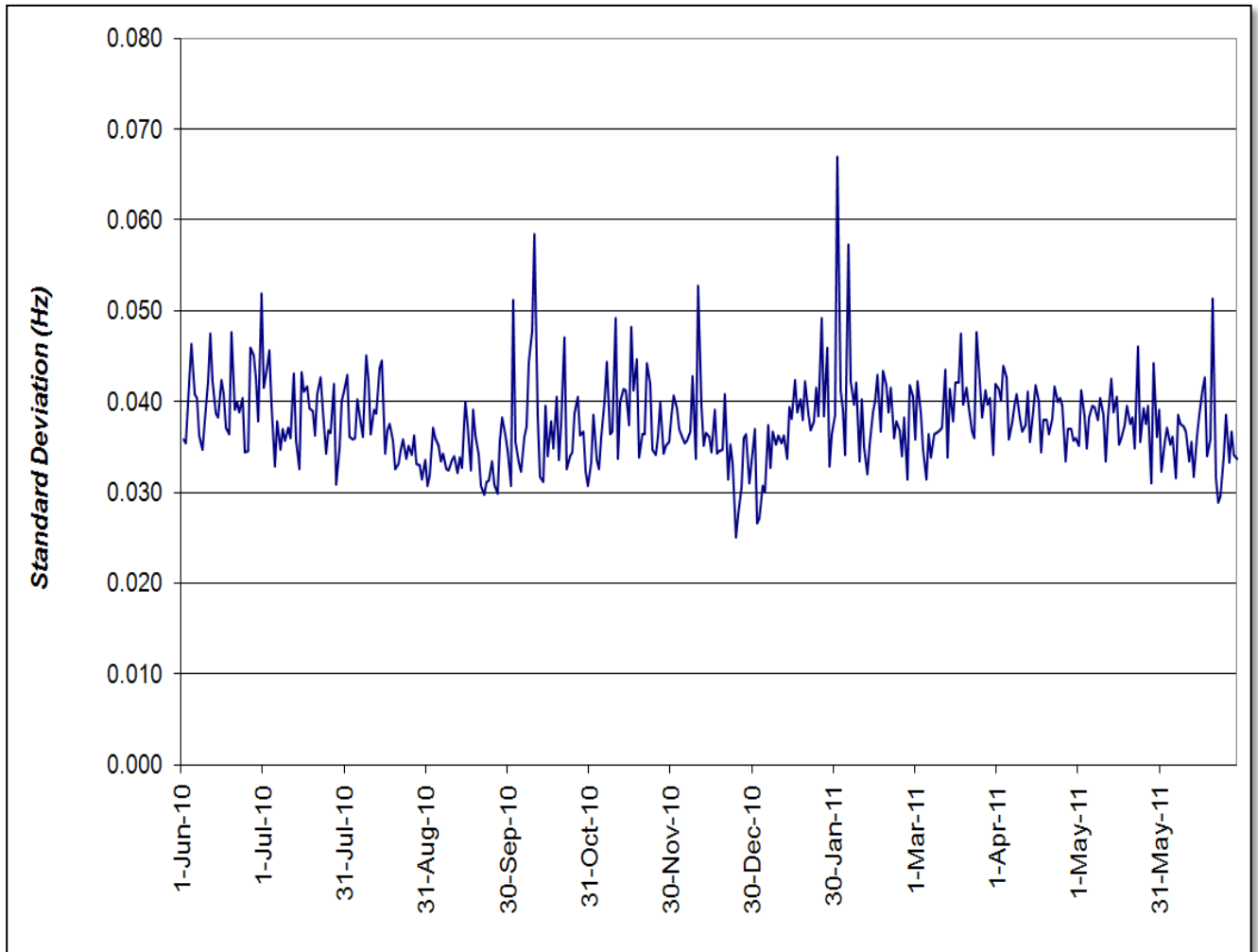


Figure 10: Daily standard deviation of frequency in Tasmania

5.1.2 Time of day Analysis

This section details the standard deviation of system frequency on a monthly and daily basis. Figure 11 and Figure 12 show the average half-hourly standard deviation of the Mainland regions and Tasmania frequency for April, May and June 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 11 and Figure 12 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 and greater than 50.25 Hz. (This assumes that the frequency distribution follows an ideal normal distribution).

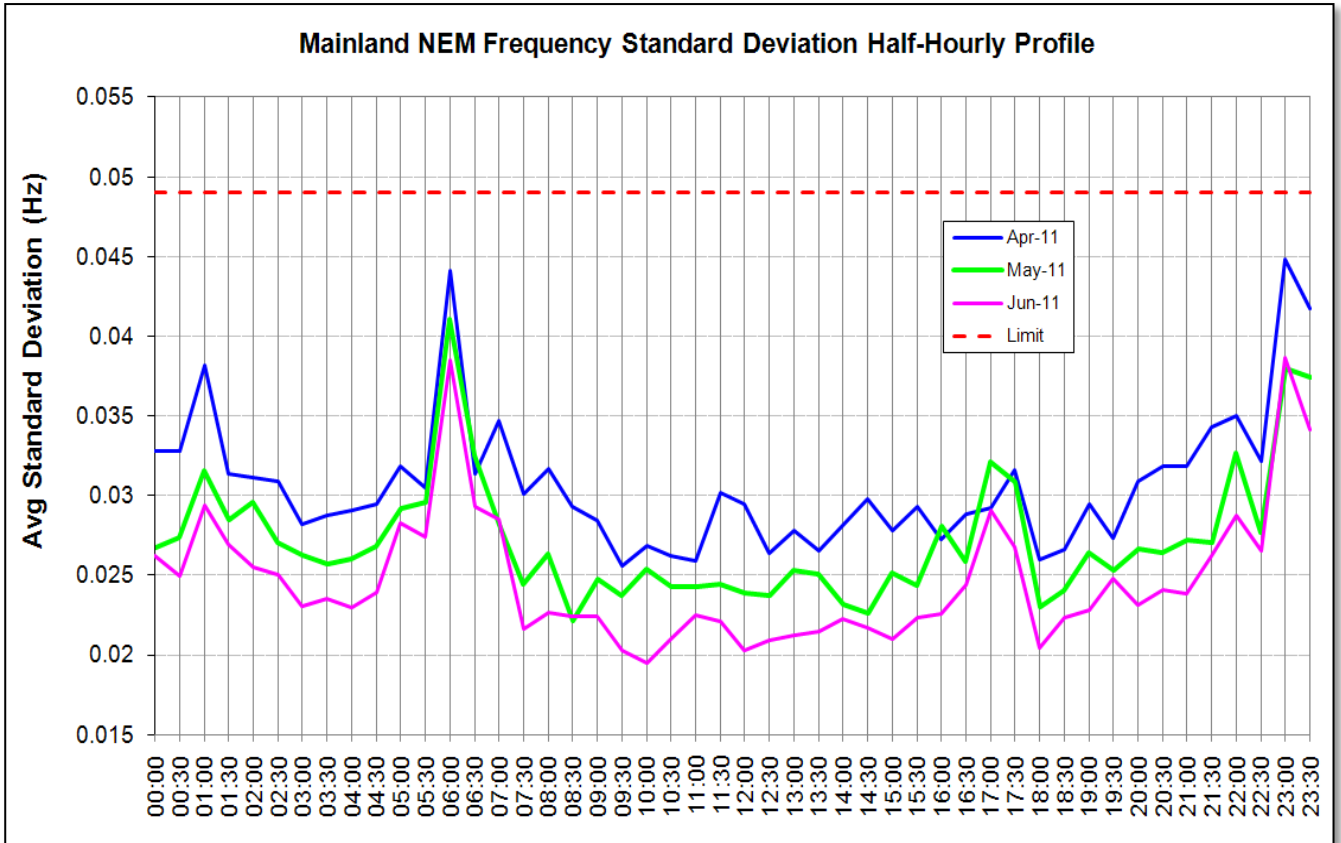


Figure 11: Daily profile of standard deviation for the frequency in the Mainland regions

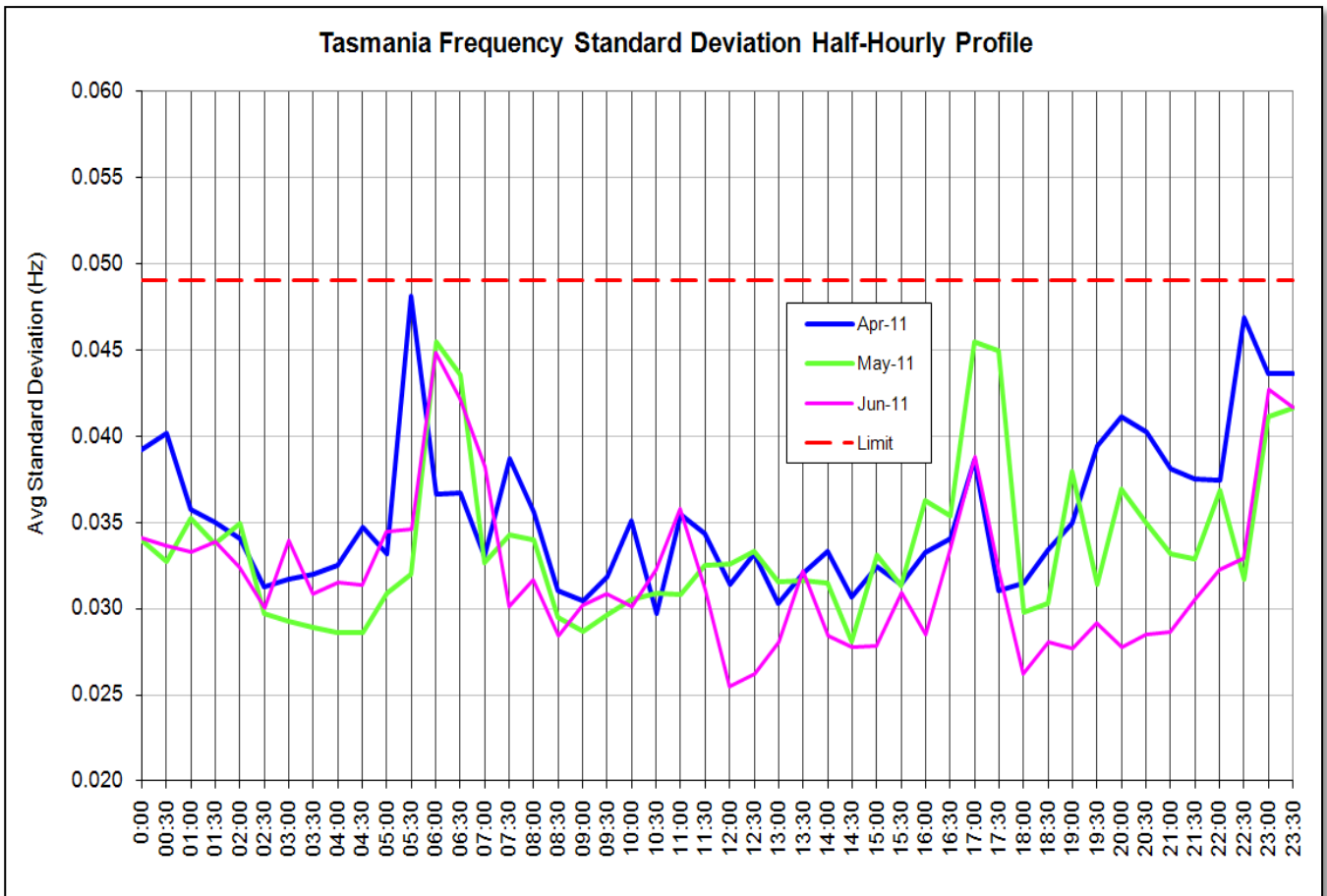


Figure 12: Daily profile of standard deviation for the frequency in Tasmania

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 June 2011 is provided in Table 3.

Table 3: Accumulated time deviation statistics

	QUEENSLAND	NSW	VIC	SA	TAS
Maximum Positive Deviation (s)	1.42	1.81	1.75	1.00	7.97
Maximum Negative Deviation (s)	-3.22	-2.79	-3.39	-3.59	-13.57
Mean Value (s)	-0.413	0.033	-0.278	-0.800	-0.201
Standard Dev (s)	0.700	0.698	0.713	0.700	1.690

The distribution of time deviations based on the mainland regions measurement is provided in Figure 13 below.

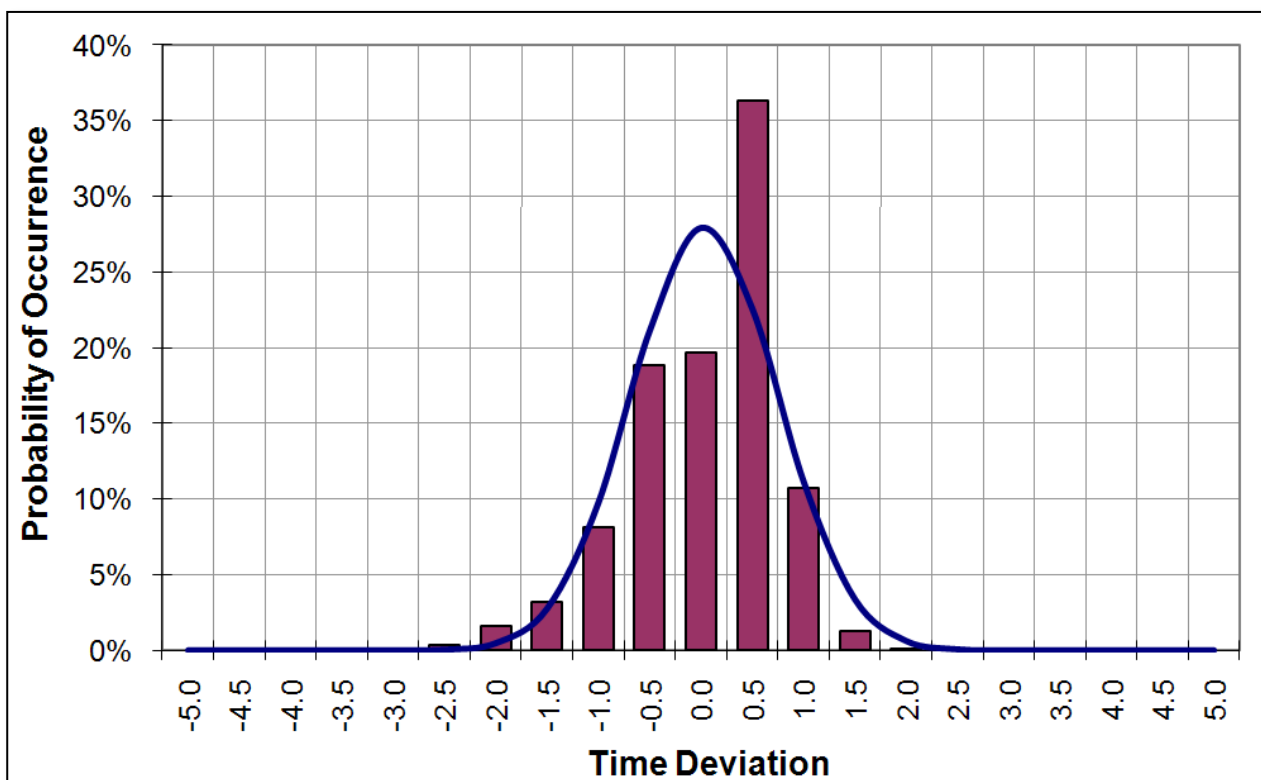


Figure 13: Mainland time deviation distribution for June 2011

The distribution of time deviations based on the Tasmania region measurement is provided below in Figure 14 below.

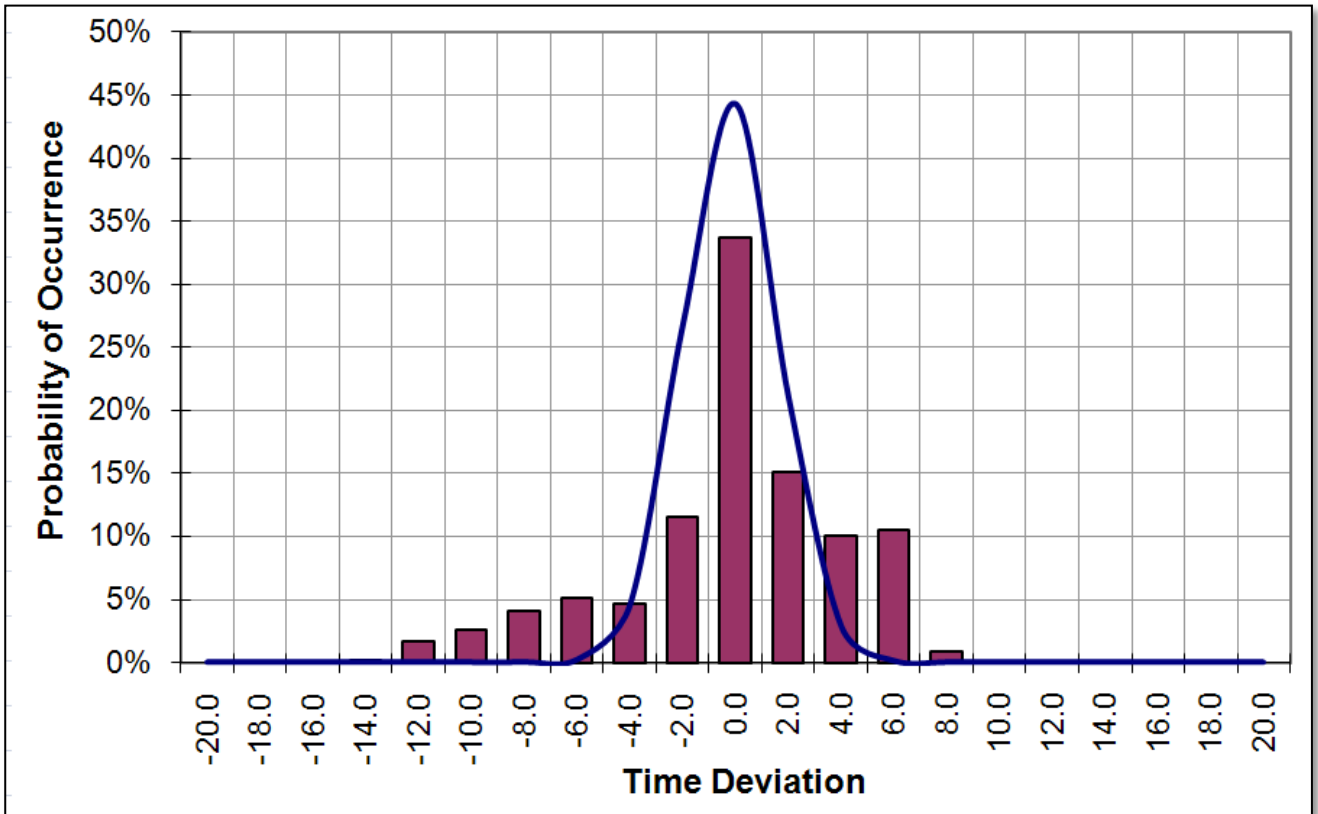


Figure 14: Tasmania time deviation distribution for June 2011

6.1 Time Error Performance

Figure 15 below presents the daily maximum and minimum values of the mainland regions time error observed for the past 13 months.

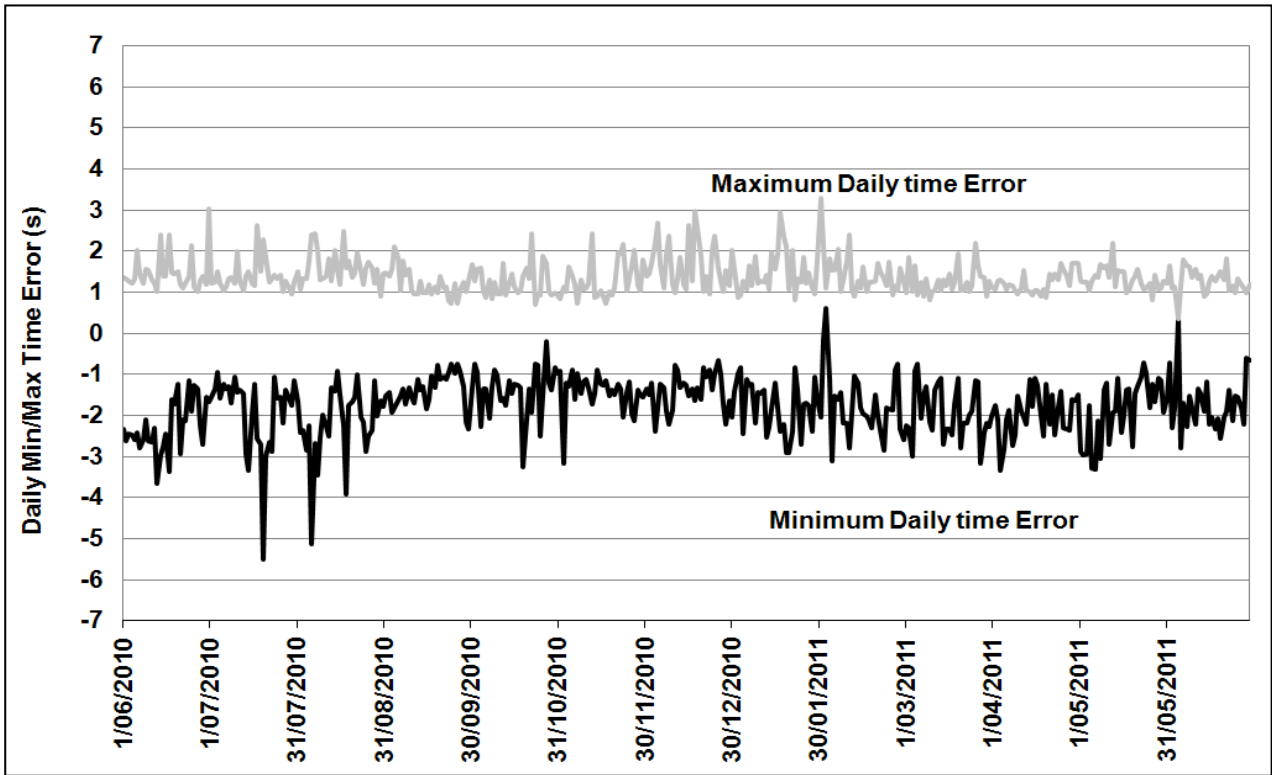


Figure 15: Mainland regions daily maximum and minimum time deviation

Figure 16 presents the daily maximum and minimum values of Tasmania time error observed for the past 13 months.

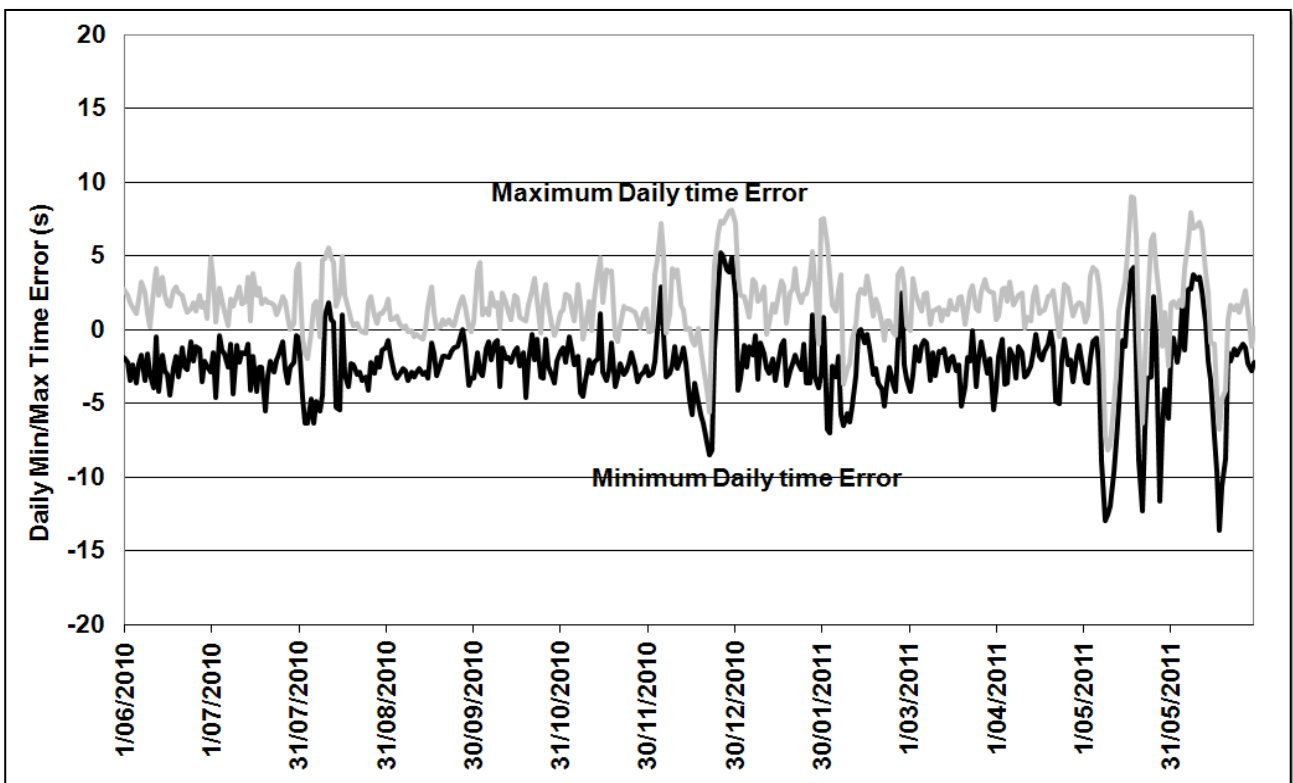


Figure 16: Tasmania daily maximum and minimum time deviation