POWER SYSTEM FREQUENCY AND TIME DEVIATION MONITORING

April 2011

PREPARED BY: Electricity System Operations Planning and Performance

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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 April 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 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-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 April 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	**4**	**48**
	HIGH	**0**	**12**
Load Event	LOW	**0**	**61**
	HIGH	**0**	**189**
Generation Event	LOW	**8**	**10**
	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 Low Frequency Events in Mainland

There was one Low Frequency Generation Event in Mainland Region during April 2011 that did not meet the Mainland Frequency Operating Standards.

This event occurred on 13th April 2011 at 1156 hrs, and this event resulted in frequency below 49.85 Hz. This event did not meet the Mainland Frequency Operating Standards because the Mainland frequency failed to recover in 5 minutes, the event details have been recorded in Table 2.

Table 2: The Low Frequency Generation Events in the Mainland region resulting in frequency below 49.85 Hz with recovery time exceeding 300 seconds

DATE	EVENT	MAINLAND		TASMANIA (BASSLINK TRANSFERRING FCAS)	
		MIN FREQUENCY (HZ)	BELOW 49.85 HZ OR ABOVE 50.15 HZ FOR (SECONDS)	MIN FREQUENCY (HZ)	BELOW 49.85 HZ OR ABOVE 50.15 HZ FOR (SECONDS)
13/04/2011 11:56:44	Vales Point Unit 6 tripped from 660 MW at 11:55 hrs.	49.73	343	49.59	192

On 13th April 2011 at 1156 hrs, Vales Point unit 6 tripped. This resulted in the power system frequency deviating below the lower limit of the Mainland Frequency Operating Standards for 343 seconds. During this event the Vales Point unit 6 was not enabled for raise FCAS.

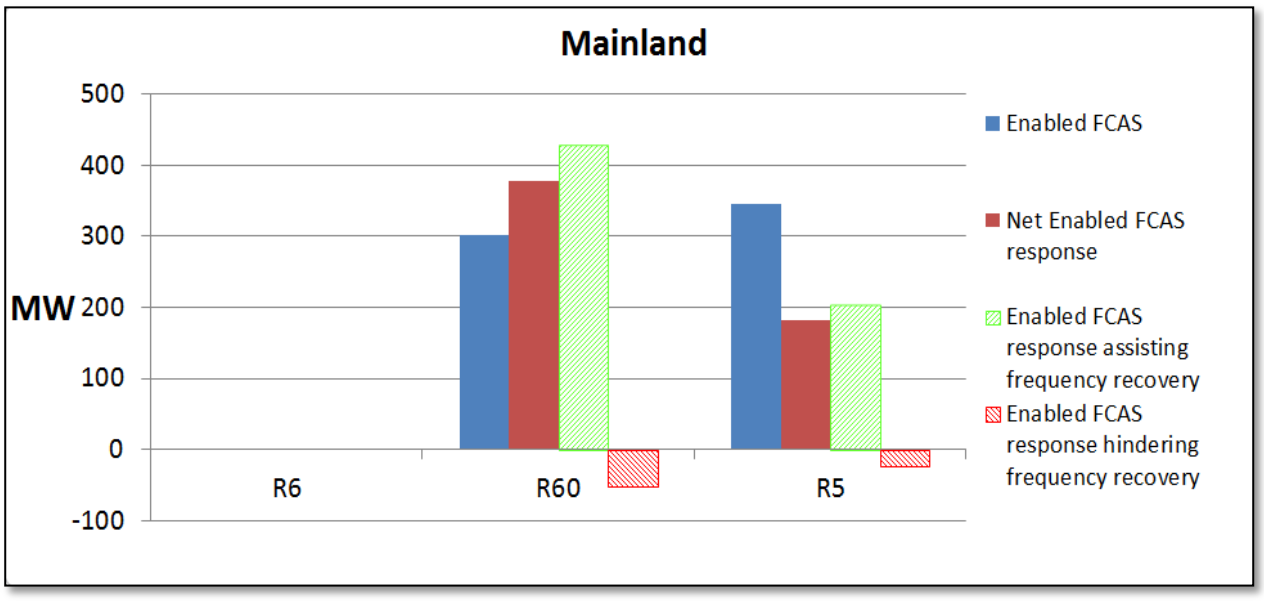

Figure 1: FCAS response to the Low Frequency Generation Event in the Mainland in Table 2 on 13th April 2011.

In response to the low frequency generation event in Table 2 on 13th April 2011, the total amounts of Raise Slow and Raise Delayed services delivered by enabled plants can be seen in Figure 1, the net delivered R60 FCAS exceeded the enablement while the net delivered R5 FCAS was less than the enablement. The amount of Raise Fast services delivered was not calculated since 50 ms data was not requested for this event. Basslink transferred FCAS to the Mainland by reducing the export to Tasmania during the time of the frequency excursion in the Mainland. The Mainland frequency dropped to minimum of 49.73 Hz, which triggered some of the switched controllers to provide delayed FCAS in Mainland

The Mainland region frequency during this event is shown in Figure 2 below:

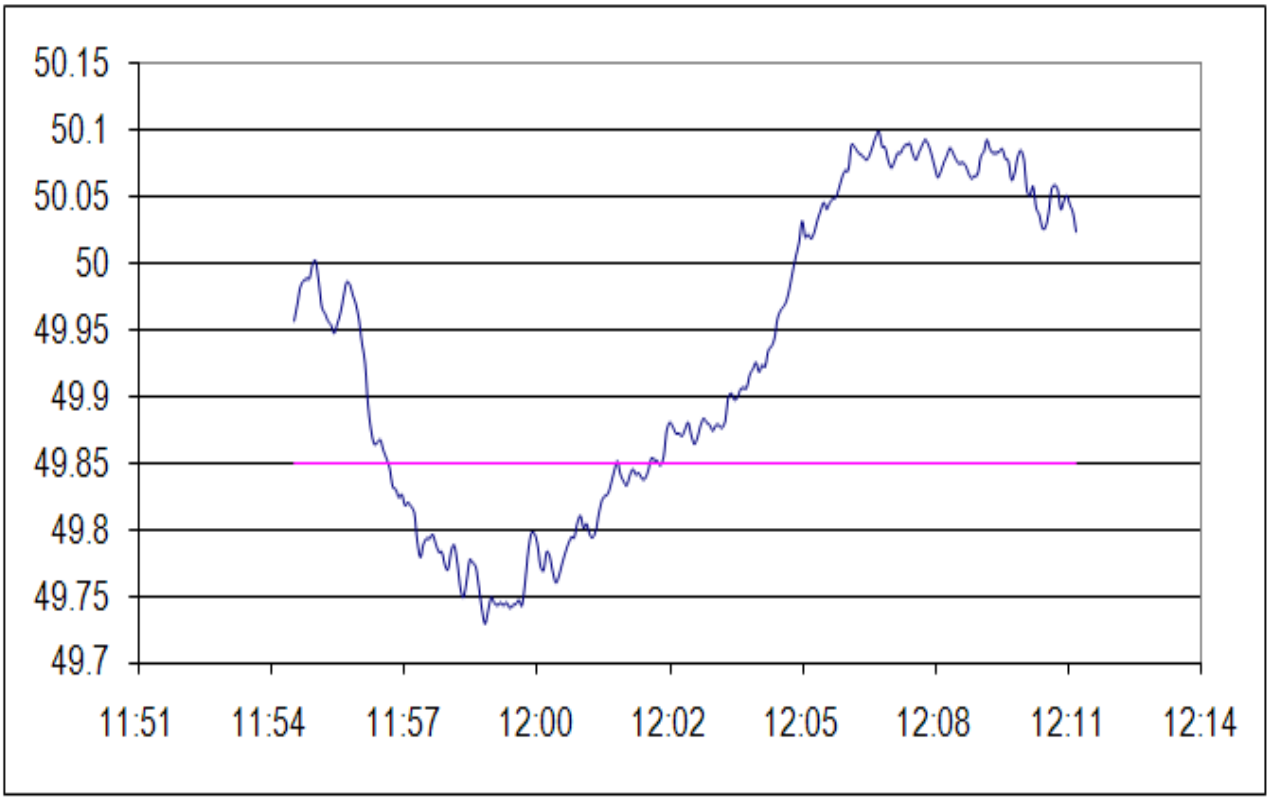

Figure 2: Mainland frequency during the Low Frequency Generation in Table 2 on 13th April 2011.

As a consequence of the low frequency in the Mainland region, the Basslink frequency controller operated to lower the frequency in Tasmania to provide FCAS service to the Mainland. Frequency fell to a minimum of 49.58 Hz in the Tasmanian region as shown in Figure 3 below. This event is within the Tasmania Frequency Operating Standards since the Tasmania frequency recovered within the required timeframe (284 seconds).

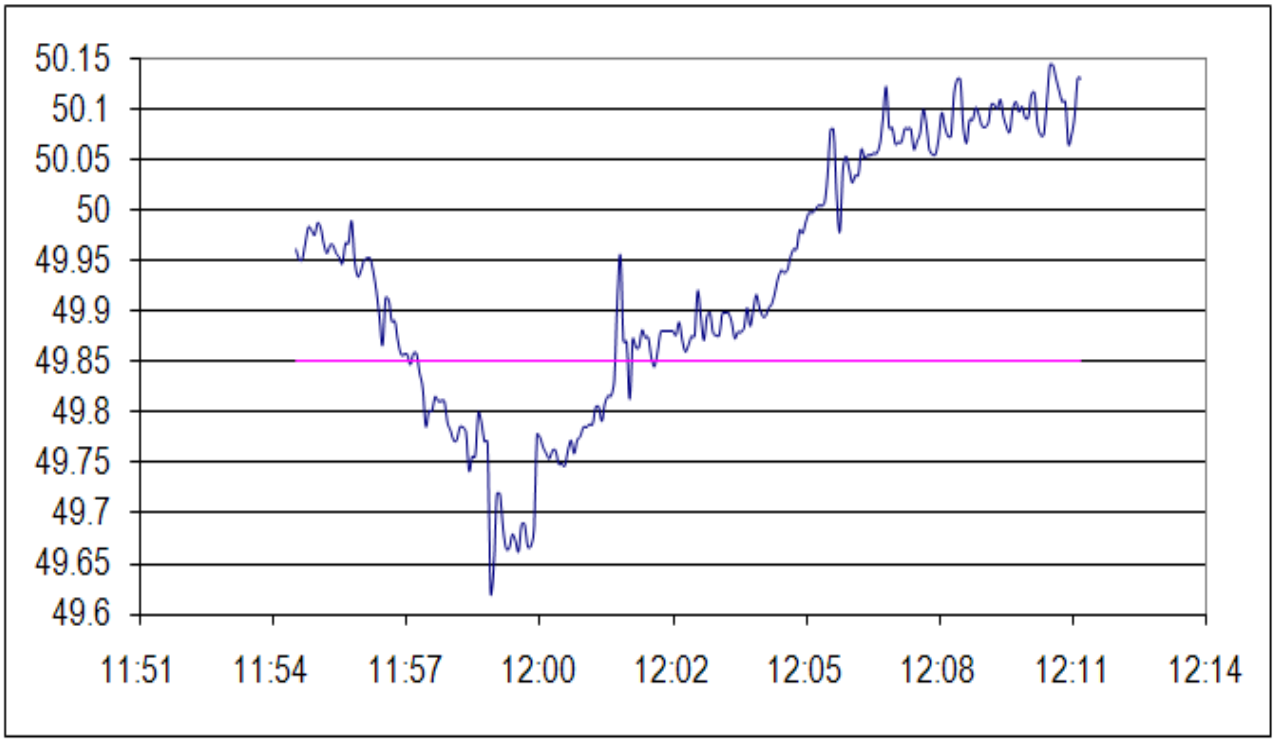

Figure 3: Tasmania frequency during the Low Frequency Generation in Table 2Table 1 on 13th April 2011.

4.2 Low Frequency Events in Tasmania

There were two Low Frequency No Contingency Events from Table 1 recorded in Tasmania during April 2011 that resulted in frequencies below 49.85 Hz. Both of these events did not meet the Tasmania Frequency Operating Standards as the frequencies during these events dropped below the threshold frequency (49.75 Hz) and failed to recover Tasmania region frequency within 5 minutes. These events are listed below in the Table 3.

Table 3: Low Frequency Events in the Tasmania region resulting in frequency below 49.75 Hz outside the Tasmania Frequency Operating Standards

DATE	EVENT	TASMANIAFREQUENCY OPERATING STANDARD	
		MIN FREQUENCY (HZ)	TIME OUTSIDE NORMAL OPERATING BAND (49.85 HZ - 50.15 HZ)
4/04/2011 6:42:48 AM	There was no load increase or generator trip that caused the event.	49.64	457
5/04/2011 06:02:56 AM	There was no load increase or generator trip that caused the event.	49.65	429

Figure 4 below shows the amounts of Raise FCAS delivered by enabled plant in Tasmania for the Low Frequency Event on 4th April 2011.

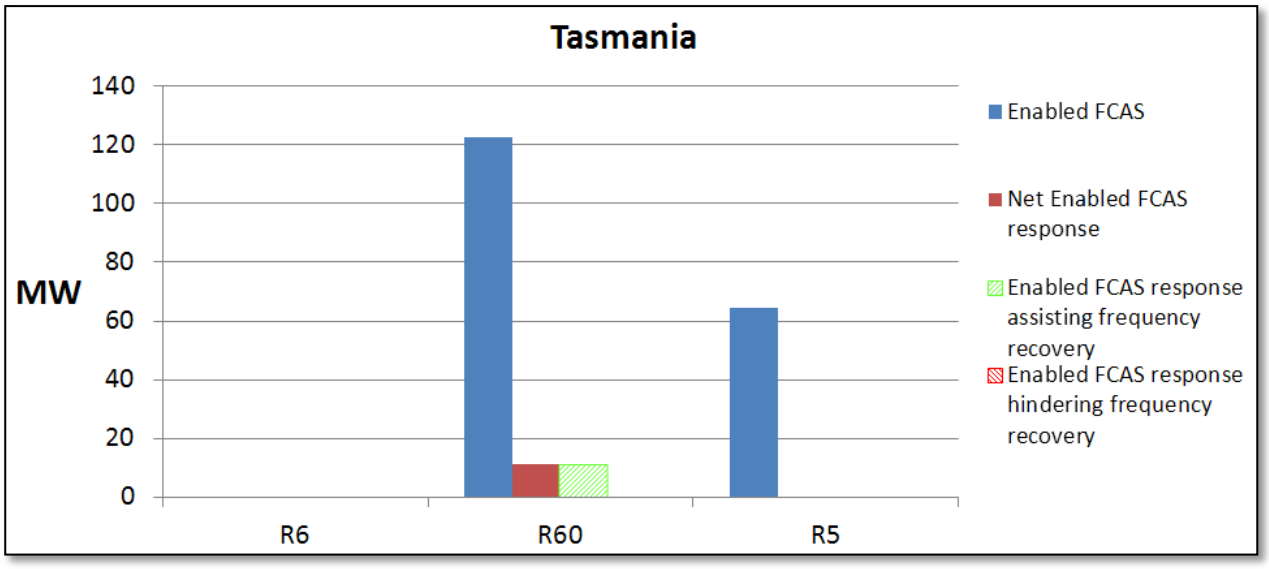

Figure 4: FCAS response to Non-Contingency Low Frequency Event on 4th April 2011 item 1 in Table 3.

For the Non-Contingency low frequency event on 4th April 2011 in Tasmania, only few generators were enabled and did not deliver enough FCAS for the frequency to recover. During the same time, three Tasmanian generators ramped up slowly to the respective generation targets from start-up, which exacerbated the frequency excursion. Compared to the enabled FCAS R60, and R5 in Tasmania, the enabled FCAS R60 services only delivered about 10% of the total enable in Tasmania. As a consequence of the low frequency in the Tasmania region, the Basslink frequency controller operated to provide FCAS service to Tasmania. The frequency excursion was not sufficient to trigger switched controllers providing delayed FCAS during the event. Frequency fell to a minimum of 49.64 Hz in the Tasmania region. The Tasmania frequency as shown in figure 5 below was outside the Tasmania Frequency operating Standards for 457 seconds. The amount of Raise Fast services delivered was not calculated since 50 ms data was not requested for this event.

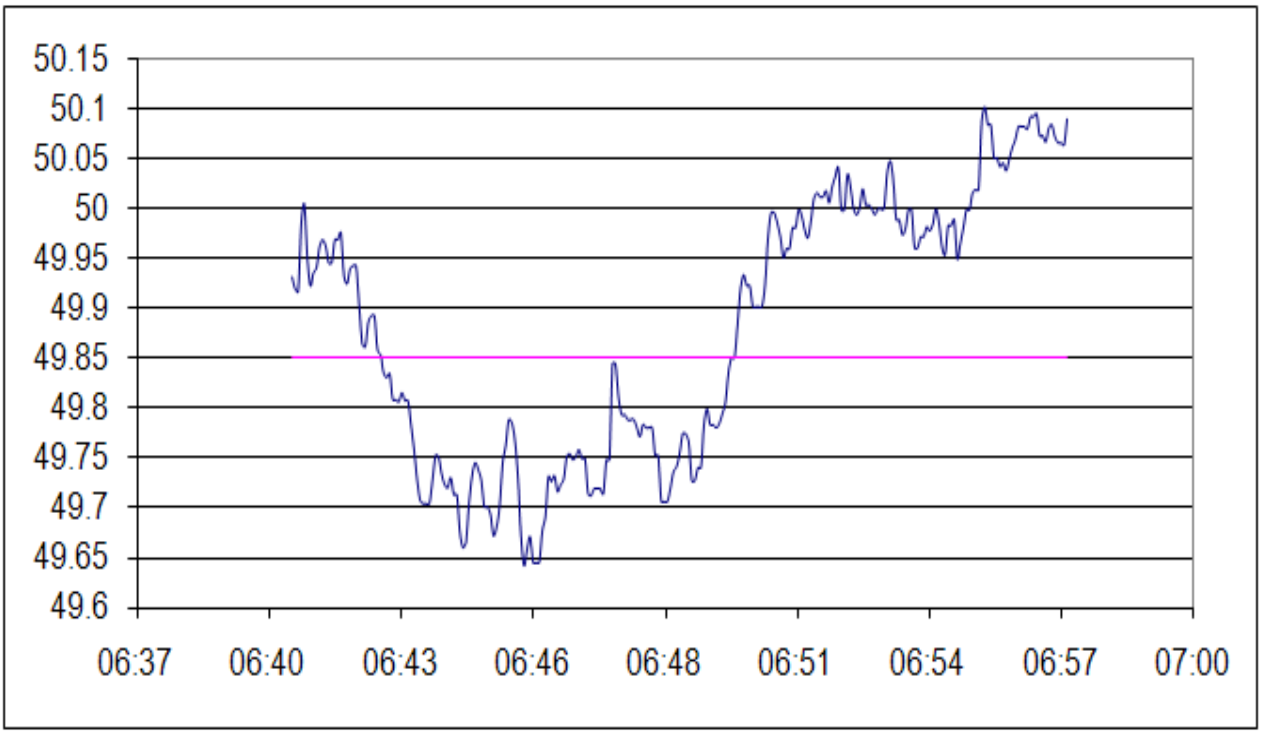

Figure 5: Non Contingency Low Frequency Event refer to item 1 in Table 3 with the frequency outside the Tasmania Frequency Operating Standard

Figure 6 below shows the amounts of Raise FCAS delivered by enabled plant in Tasmania for the Low Frequency Event on 5th April 2011.

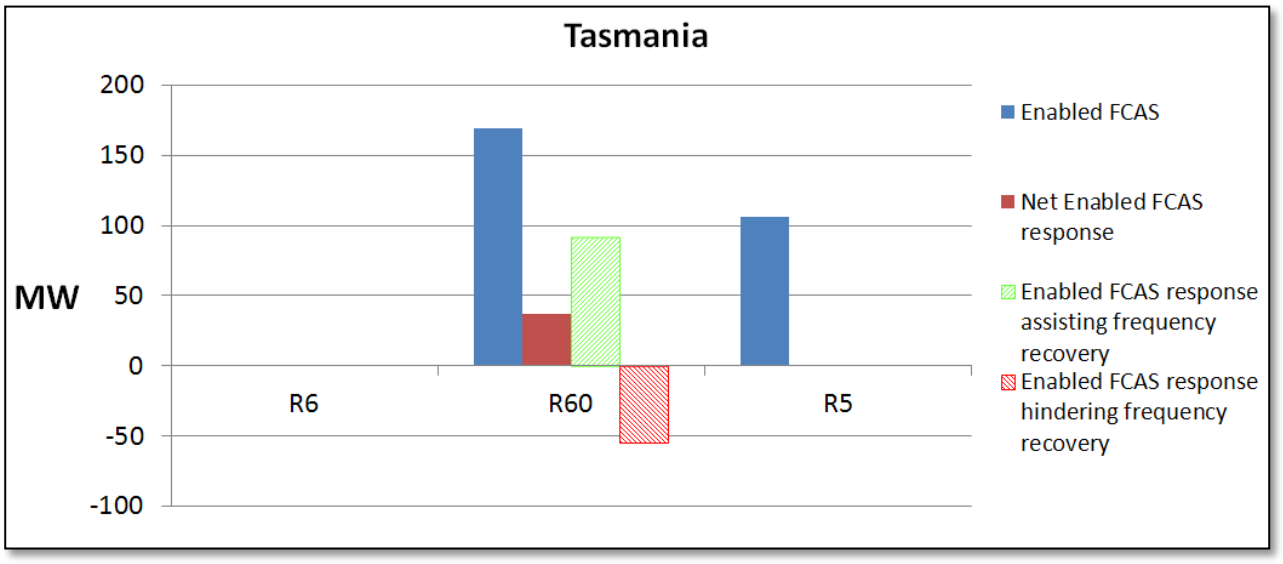

Figure 6: FCAS response to Non-Contingency Low Frequency Event on 5th April 2011 item 2 in Table 3.

For the Non-Contingency low frequency event on 5th April 2011 in Tasmania, only few generators were enabled and did not deliver enough FCAS for the frequency to recover. During the same time, two Tasmanian generators ramped up slowly to the respective generation targets from start-up, which exacerbated the frequency excursion. Compared to the enabled FCAS R60, and R5 in Tasmania, the enabled FCAS R60 services only delivered about 22% of the total enable in Tasmania. As a consequence of the low frequency in the Tasmania region, the Basslink frequency controller operated to provide FCAS service to Tasmania. The frequency excursion was not sufficient to trigger switched controllers providing delayed FCAS during the event. Frequency fell to a minimum of 49.65 Hz in the Tasmanian region. The Tasmania frequency as shown in figure 7 below was outside the Tasmania Frequency operating Standards for 429 seconds. The amount of Raise Fast services delivered was not calculated since 50ms data was not requested for this event.

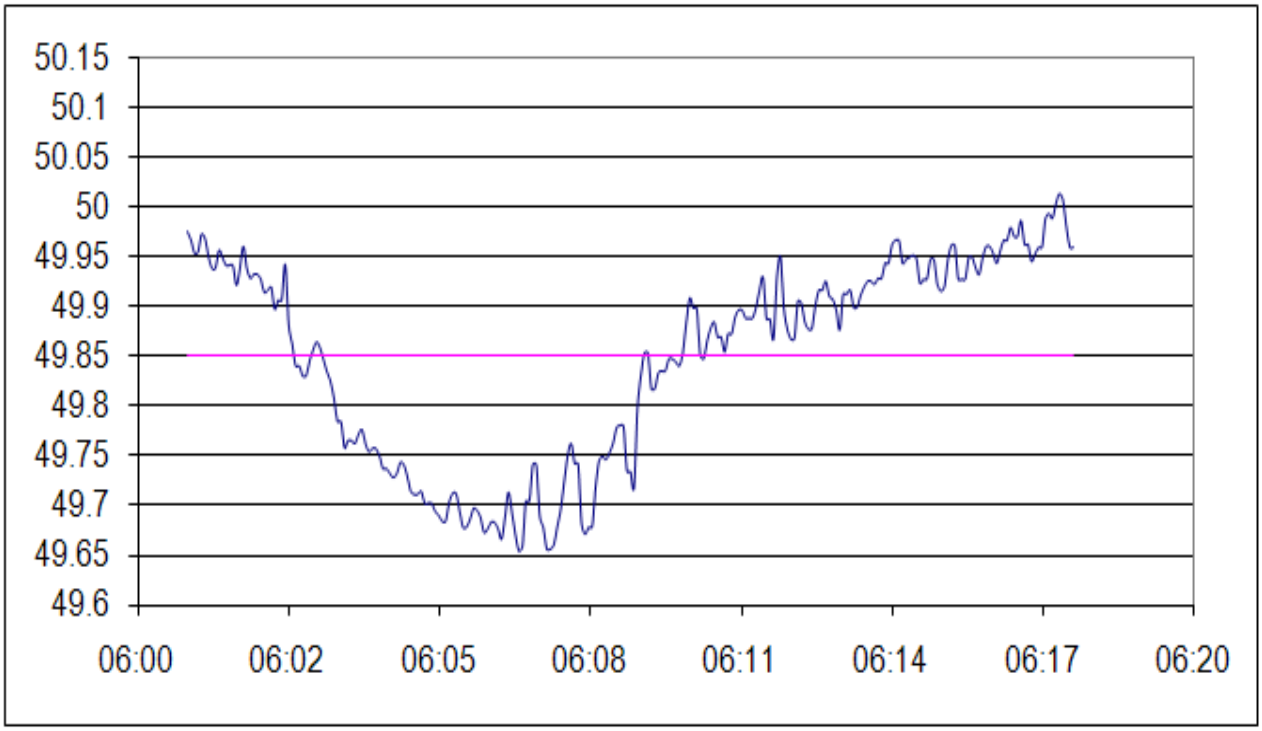

Figure 7: Non Contingency Low Frequency Event refer to item 2 in Table with the frequency outside the Tasmania Frequency Operating Standard

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 April 2011.

Frequency in the Mainland region was within the range 49.90 – 50.08 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 2011 was 50 Hz with a standard deviation of 0.034Hz.

Frequency in the Tasmania region was within the range 49.89 – 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 April 2011 was 50 Hz with a standard deviation of 0.039 Hz.

5.1.1 Daily Frequency Standard Deviation

Figure 8 and Figure 9 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.

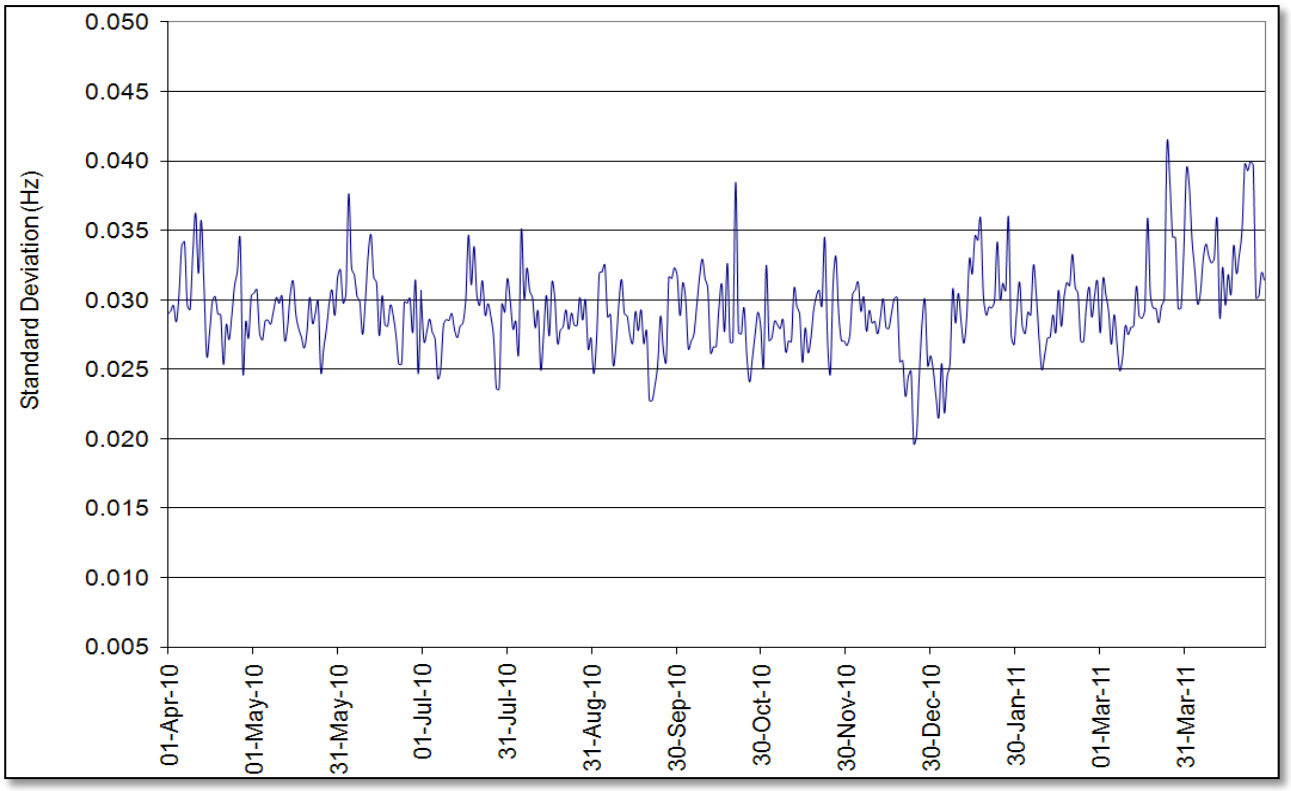

Figure 8: Daily standard deviation of Mainland frequency

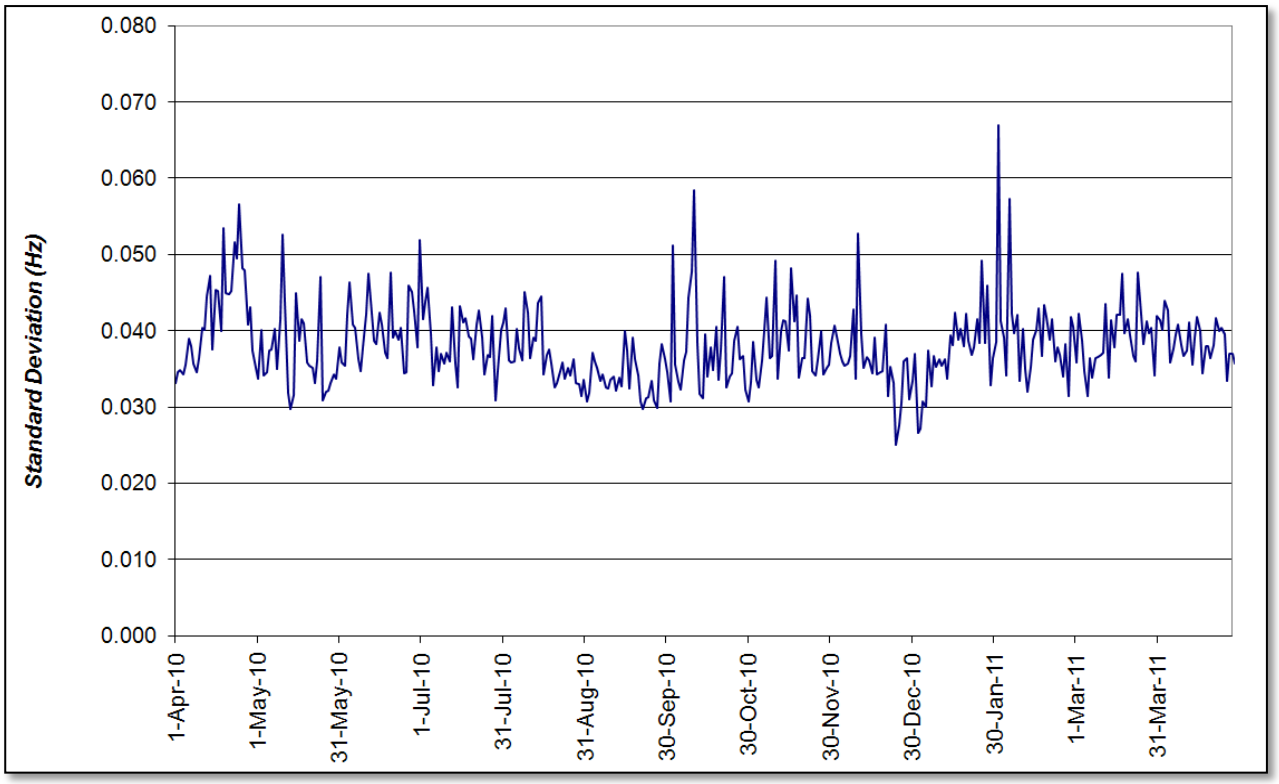

Figure 9: Daily standard deviation of frequency in Tasmania

5.1.2 Time of day Analysis

This section details the standard deviation of system frequency on a monthly and daily basis. Figure 10 and Figure 11Figure show the average half-hourly standard deviation of the Mainland regions and Tasmania frequency for Feb, March and April 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 10 and Figure 11Figure 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).

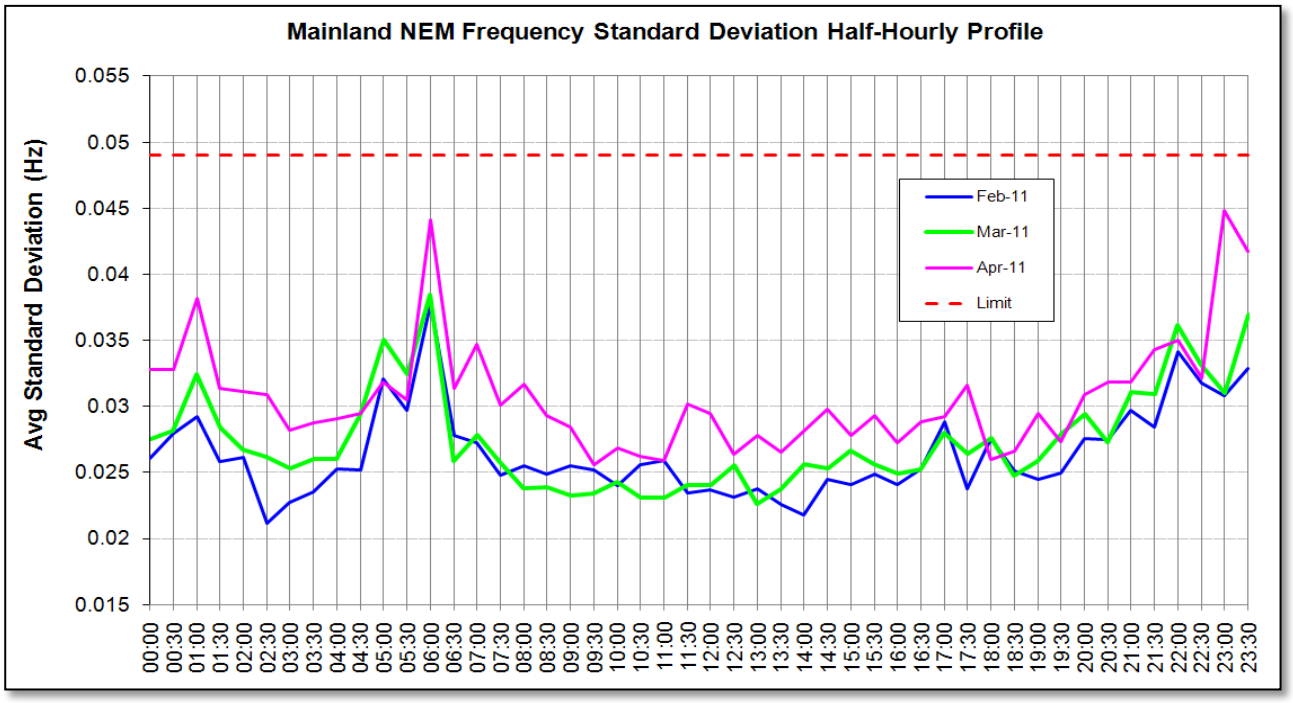

Figure 10: Daily profile of standard deviation for the frequency in the Mainland regions

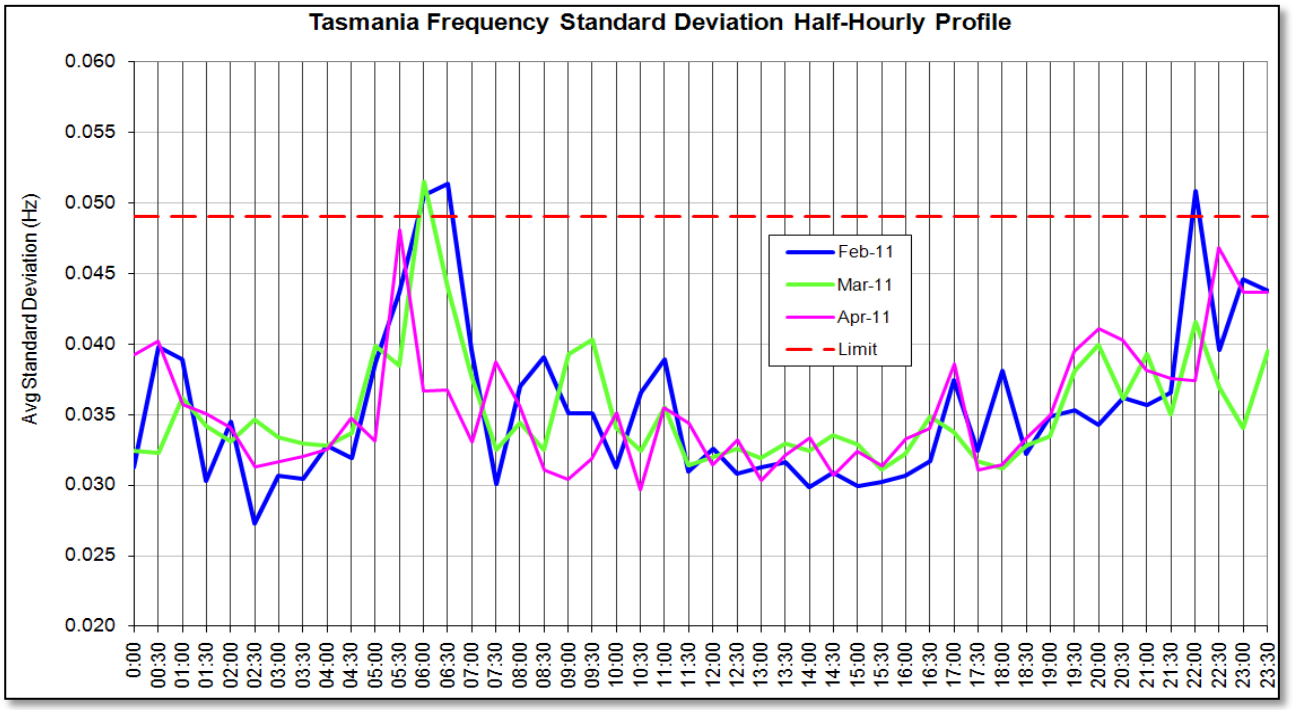

Figure 11: Daily profile of standard deviation for the frequency in Tasmania

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 2011 is provided in Table 4.

Table 4: Accumulated time deviation statistics

	QLD	NSW	VIC	SA	TAS
Maximum Positive Deviation (s)	**1.49**	**1.71**	**1.69**	**1.33**	**3.23**
Maximum Negative Deviation (s)	**-3.48**	**-3.36**	**-3.40**	**-3.65**	**-5.04**
Mean Value (s)	**-0.170**	**0.040**	**0.009**	**-0.304**	**0.030**
Standard Dev (s)	**0.637**	**0.637**	**0.637**	**0.637**	**1.302**

The distribution of time deviations based on the Mainland regions measurement is provided in Figure 12.

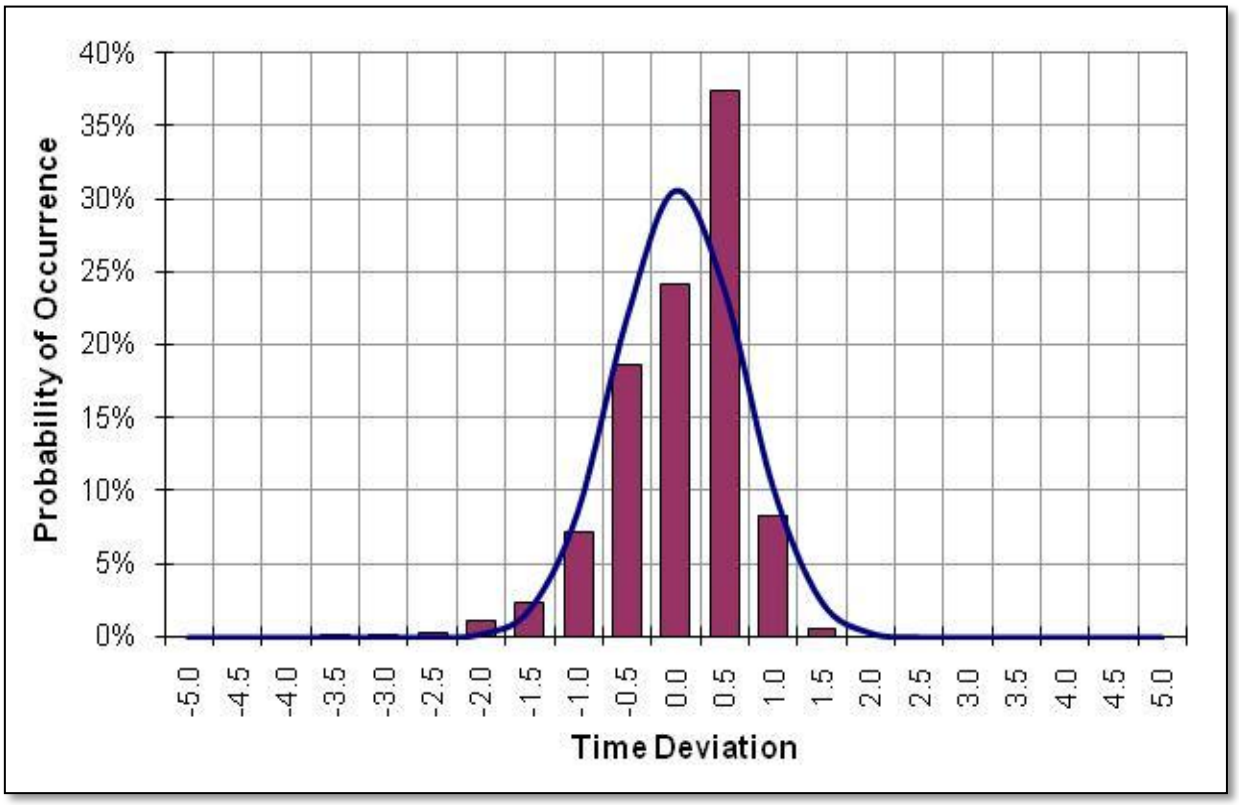

Figure 12: Mainland time deviation distribution for April 2011

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

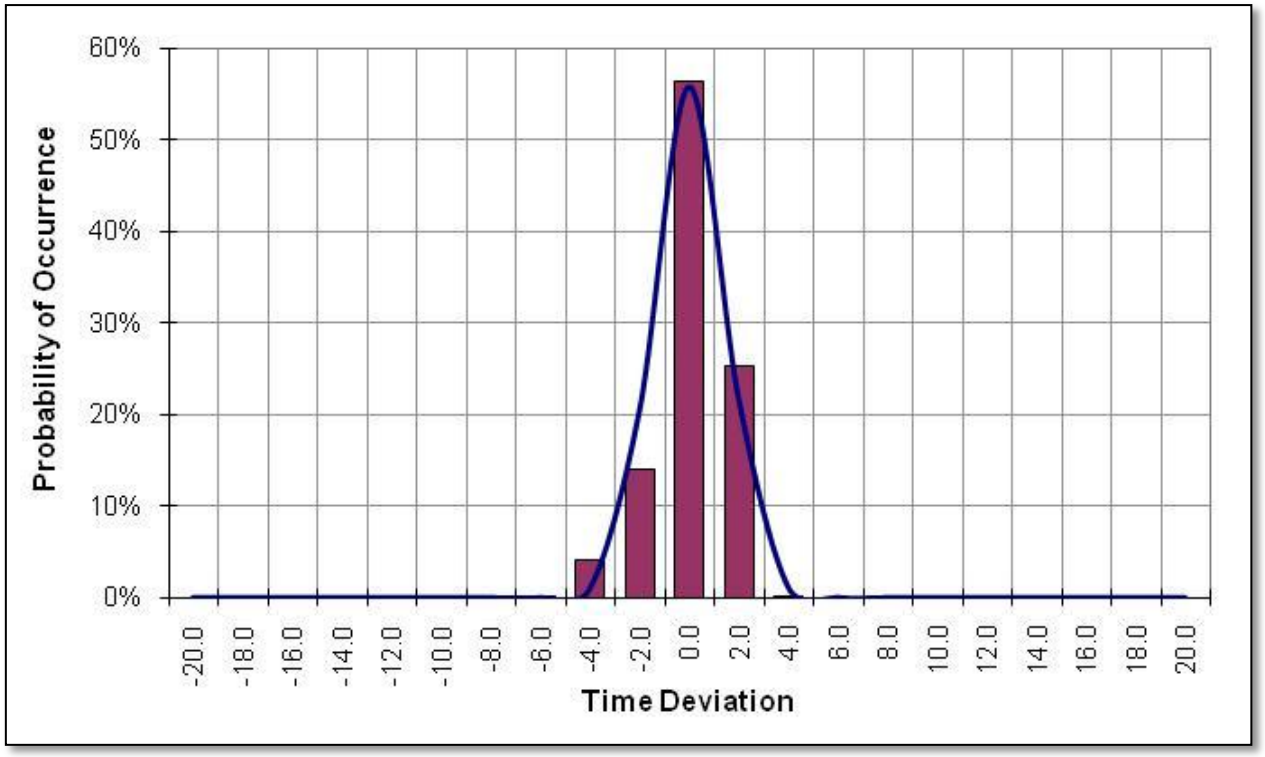

Figure 13: Tasmania time deviation distribution for April 2011

6.1 Time Error Performance

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

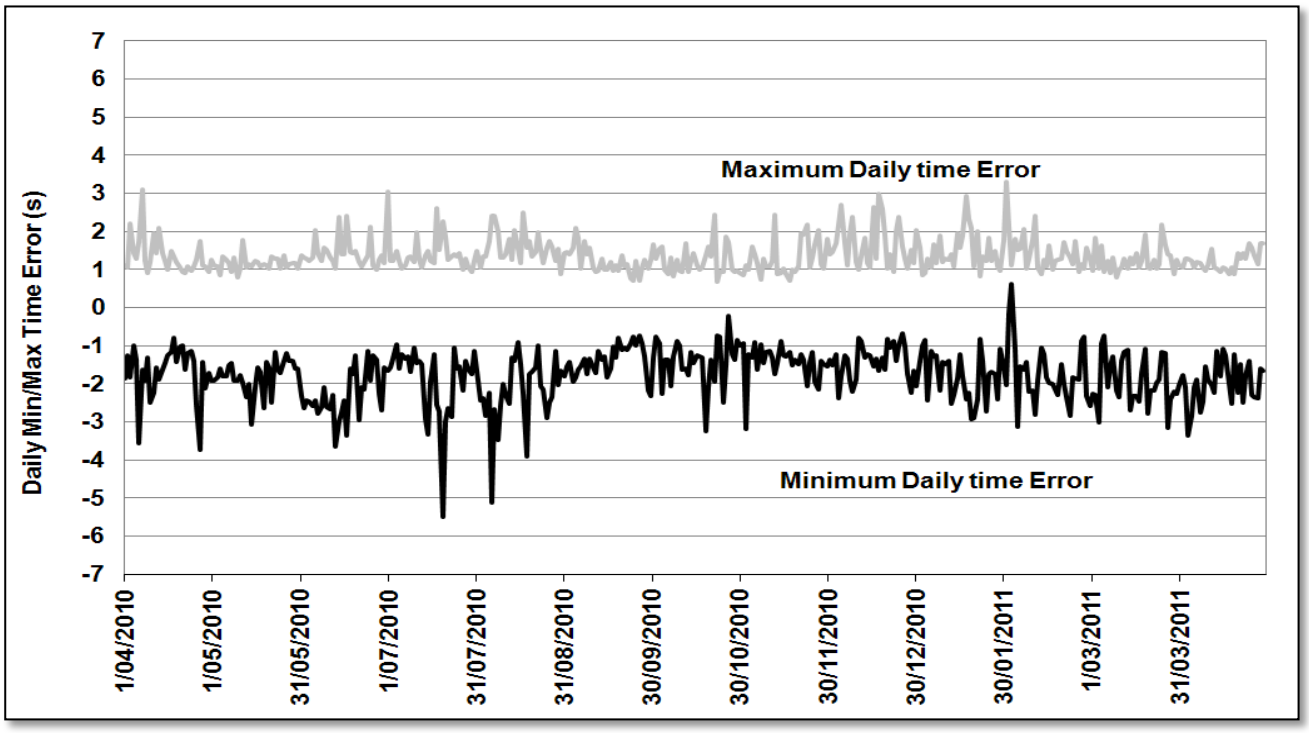

Figure 14: Mainland regions daily maximum and minimum time deviation

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

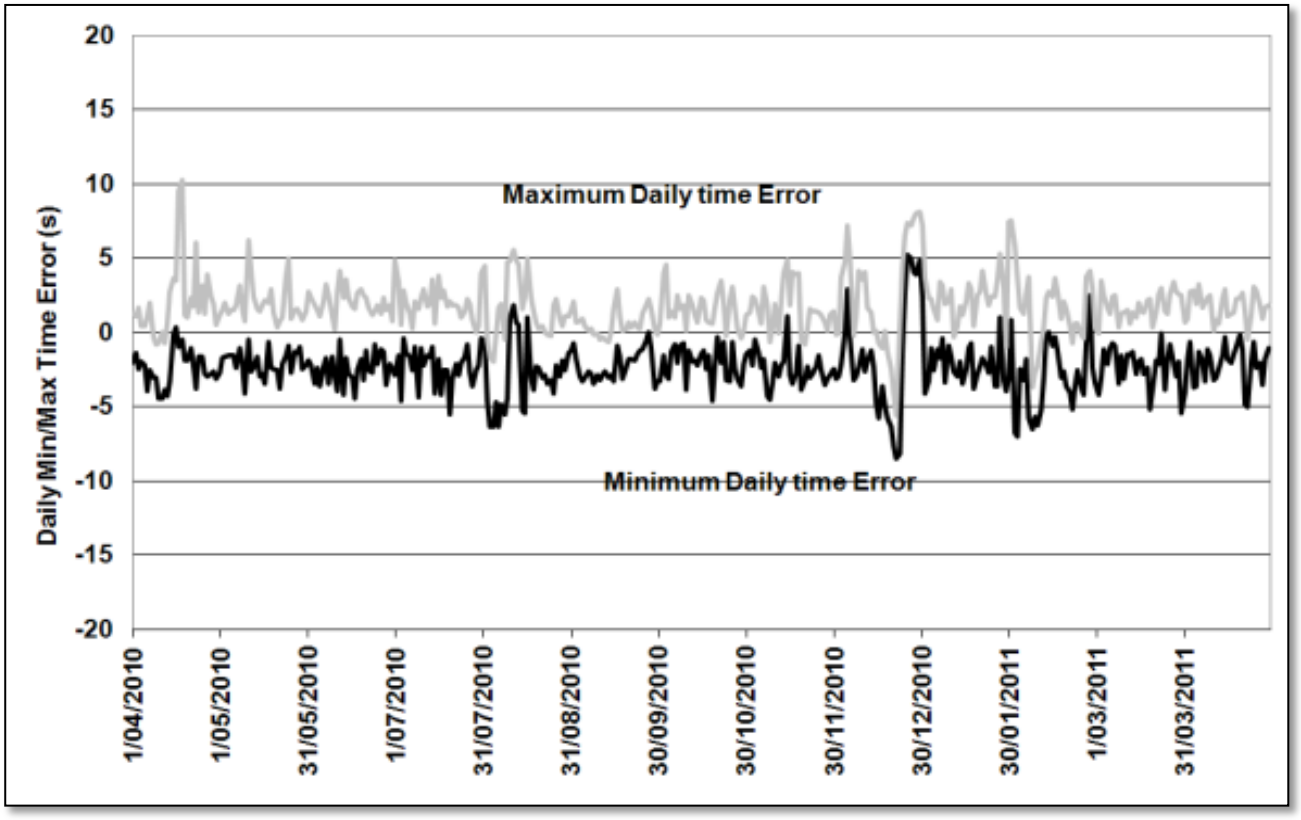

Figure 15: Tasmania daily maximum and minimum time deviation