# POWER SYSTEM FREQUENCY AND TIME DEVIATION MONITORING

March 2012

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 March 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 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 March 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 | 51 |
| | HIGH | 0 | 15 |
| Load Event | LOW | 0 | 73 |
| | HIGH | 0 | 116 |
| Generation Event | LOW | 2 | 1 |
| | HIGH | 0 | 0 |
| 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 March 2012.

## 4.2 High Frequency Events in Tasmania

There were two High Frequency Normal Condition Events from Table 1 recorded in Tasmania during March 2012 that resulted in frequencies above 50.25 Hz. All of these events listed in Table 2 did not meet the Tasmania Frequency Operating Standards.

*Table 2: High 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) |
|---|---|---|---|
| 15/03/2012 17:47:36 | No condition causing the event was identified. | 50.33 | 132 |
| 29/03/2012 05:22:08 | No condition causing the event was identified. | 50.26 | 12 |

### 4.2.1 Event: 15/03/2012 17:47:36

For the Normal (Non-Contingency) high frequency event on 15th Mar 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 132 seconds. One Tasmanian generating unit ramped up by about 37 MW above its generation target and concurrently a Tasmania load reduced by about 8 MW. Both of these sudden changes in generation and load contributed to the frequency excursion. Compared to the enabled slow lower and delayed lower FCAS, 24% of the slow lower FCAS was delivered as shown in Figure 2. The flow across Basslink was approximately 48 MW into Tasmania 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. Frequency rose to a maximum of 50.33 Hz in the Tasmania region. The amount of Fast Lower services delivered was not calculated since 50 ms data was not requested for this event.

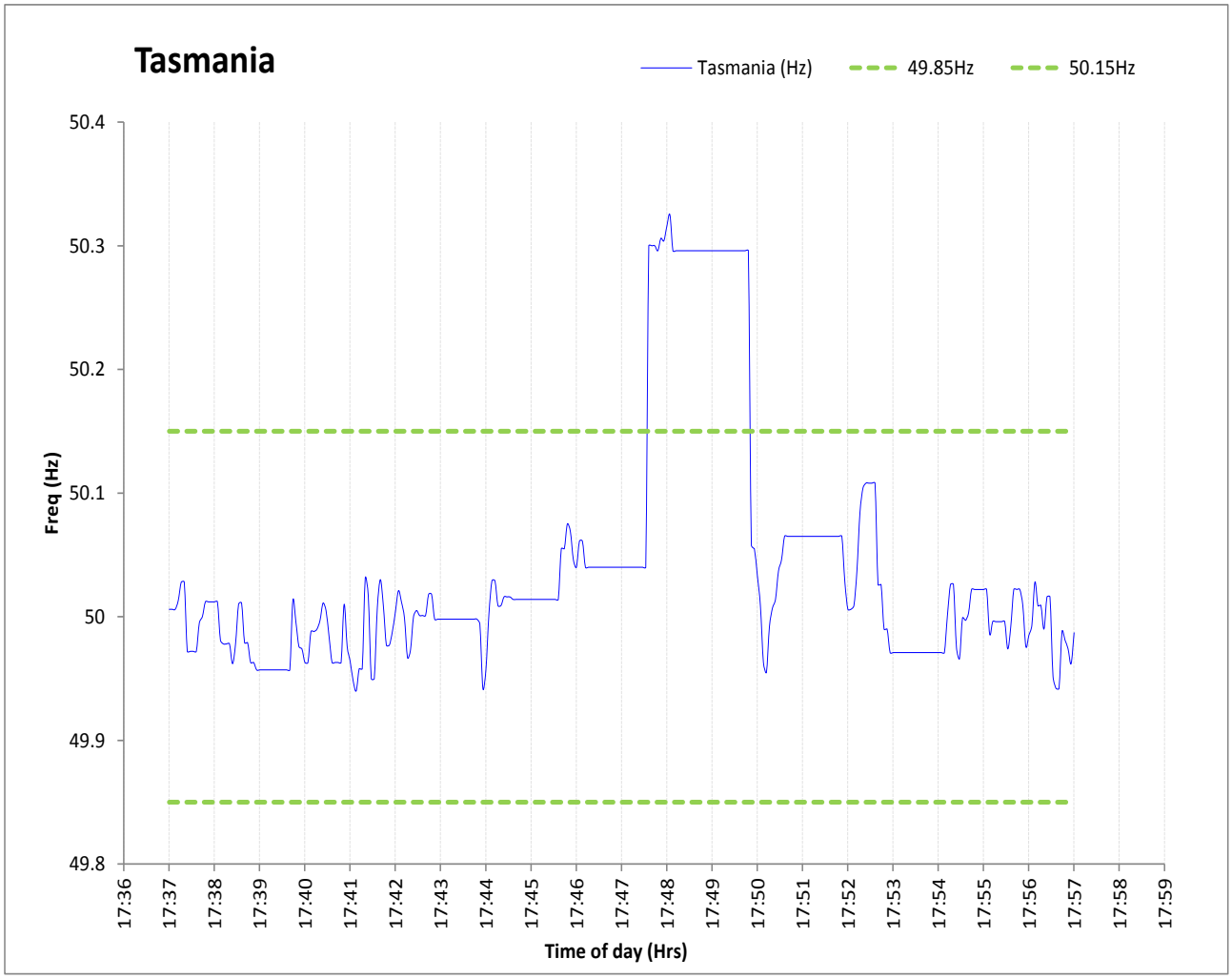


*Figure 1: High Frequency Normal Event in Tasmania refer to item 1 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.*

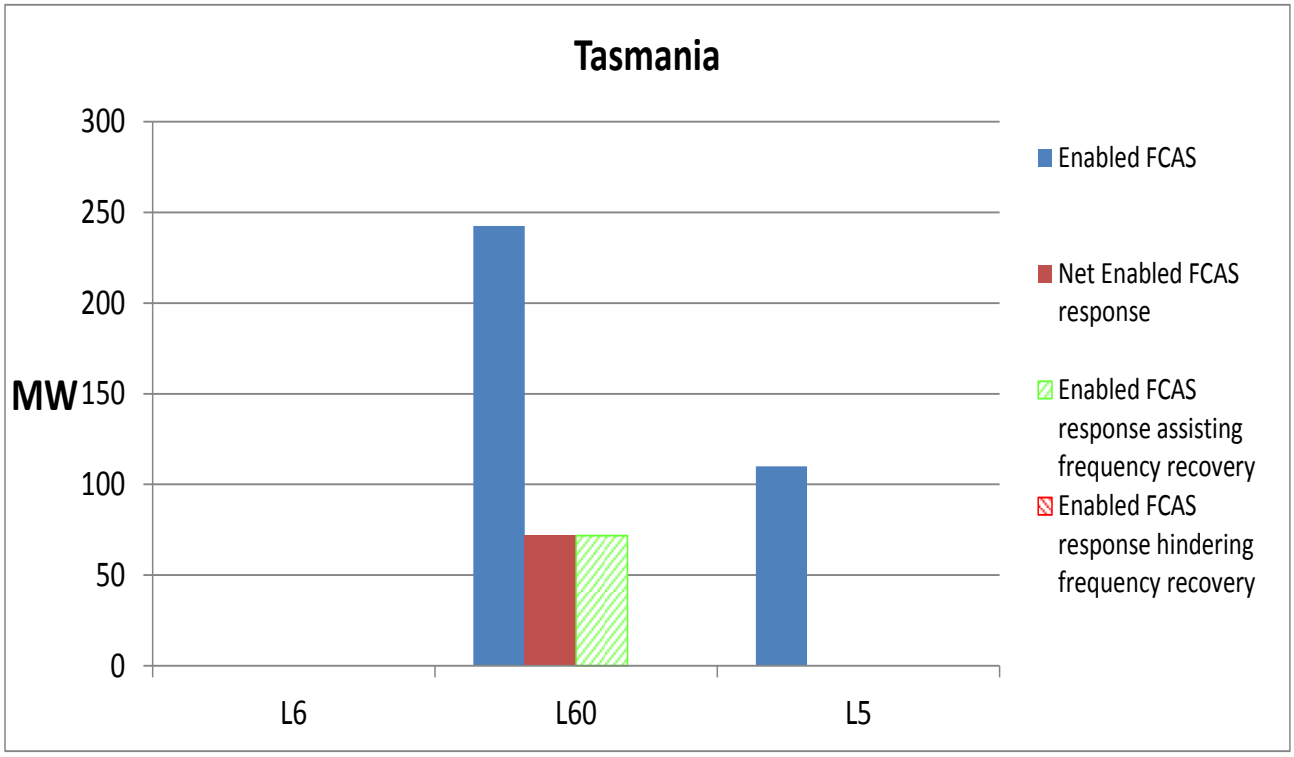


*Figure 2: FCAS response to Normal (Non-Contingency) High Frequency Event on 15th Mar 2012.*

### 4.2.2 Event: 29/03/2012 05:22:08

For the Normal (Non-Contingency) high frequency event on 29th Mar 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 12 seconds. One Tasmanian generating unit ramped up rapidly above its generation target which contributed to the frequency excursion. Compared to the enabled slow lower and delayed lower FCAS, a zero amount was delivered as shown in Figure 4. The flow across Basslink was approximately 47 MW into Tasmania 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. Frequency rose to a maximum of 50.26 Hz in the Tasmania region. The amount of Fast Lower services delivered was not calculated since 50 ms data was not requested for this event.

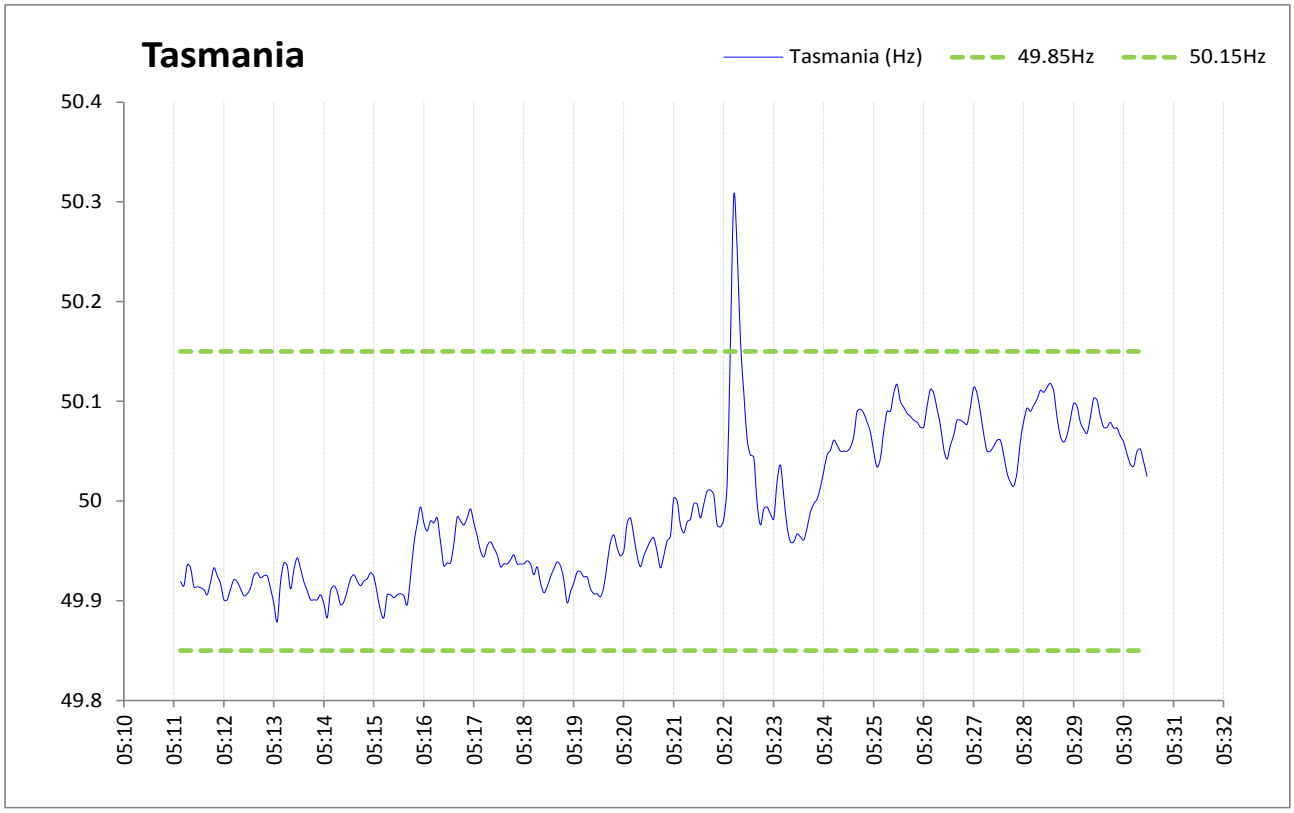


*Figure 3: High Frequency Normal Event in Tasmania refer to item 2 in Table 2 with the frequency exceeding the Tasmania Frequency Operating Standard.*

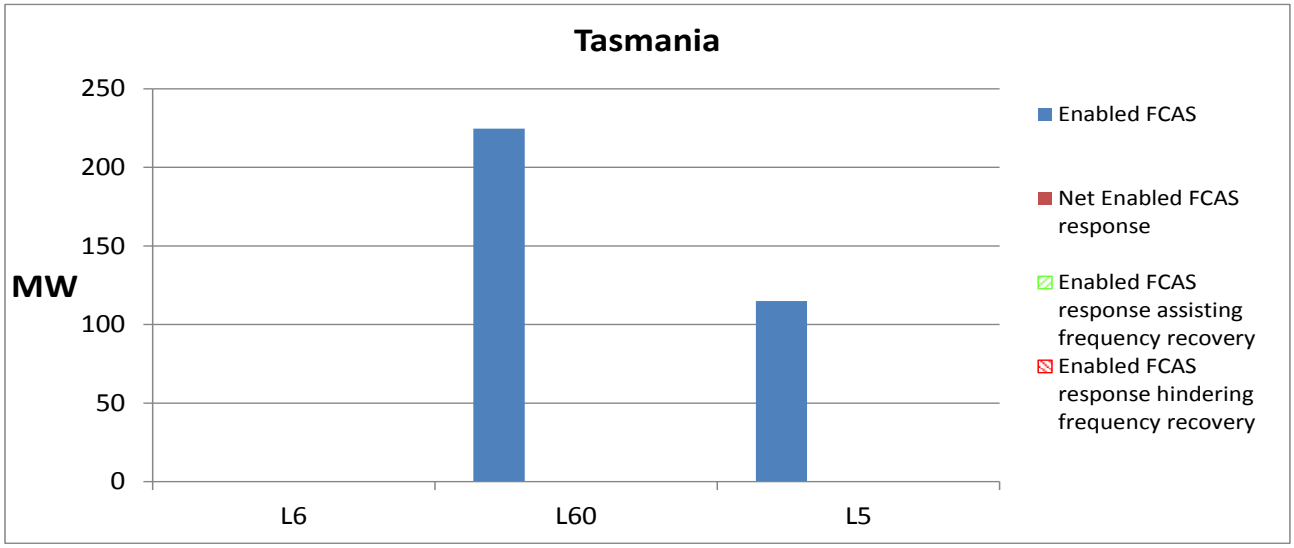


*Figure 4: FCAS response to Normal (Non-Contingency) High Frequency Event on 29th Mar 2012.*

# 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 March 2012.

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 for 100% of the time. The mean value of frequency during March 2012 was 50 Hz with a standard deviation of 0.028 Hz.

Frequency in the Tasmania region was within the range 49.90 to 50.09 Hz for 99% of the time. The frequency was within the range 49.75 Hz – 50.25 for 99.98 % of the time. The mean value of frequency during March 2012 was 50 Hz with a standard deviation of 0.037 Hz.

### 5.1.1 Daily Frequency Standard Deviation

Figure 5 and Figure 6 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.

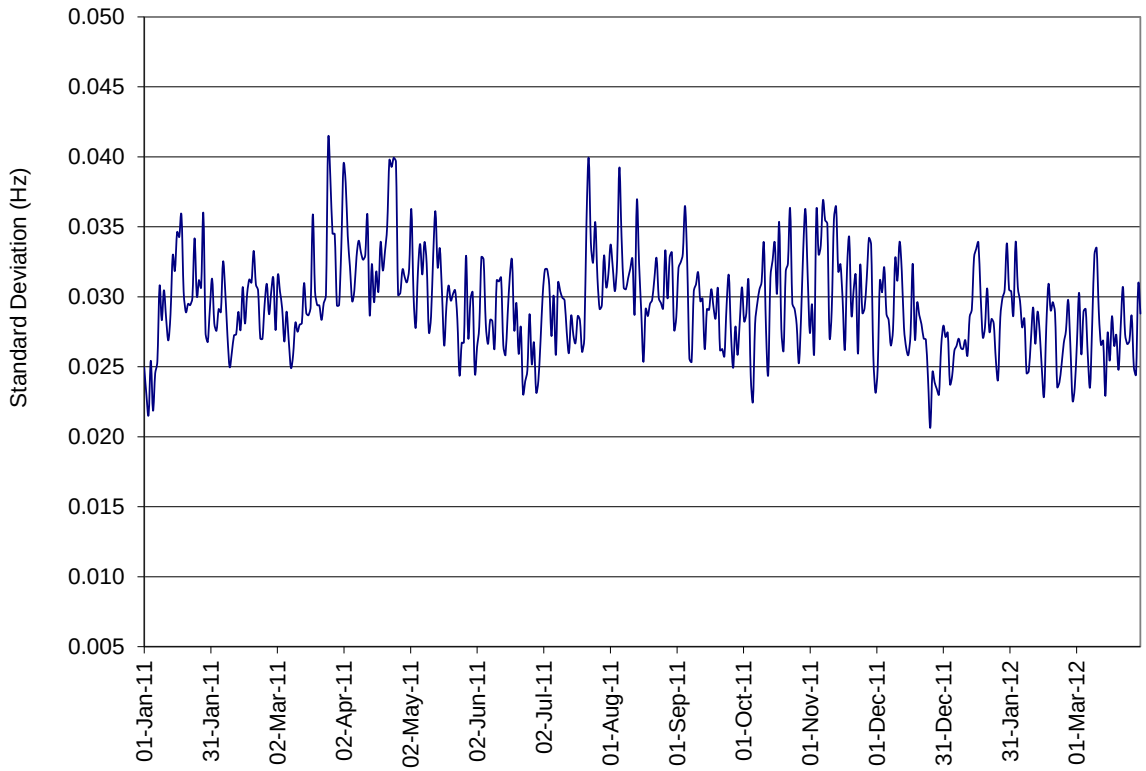


*Figure 5: Daily standard deviation of Mainland frequency.*

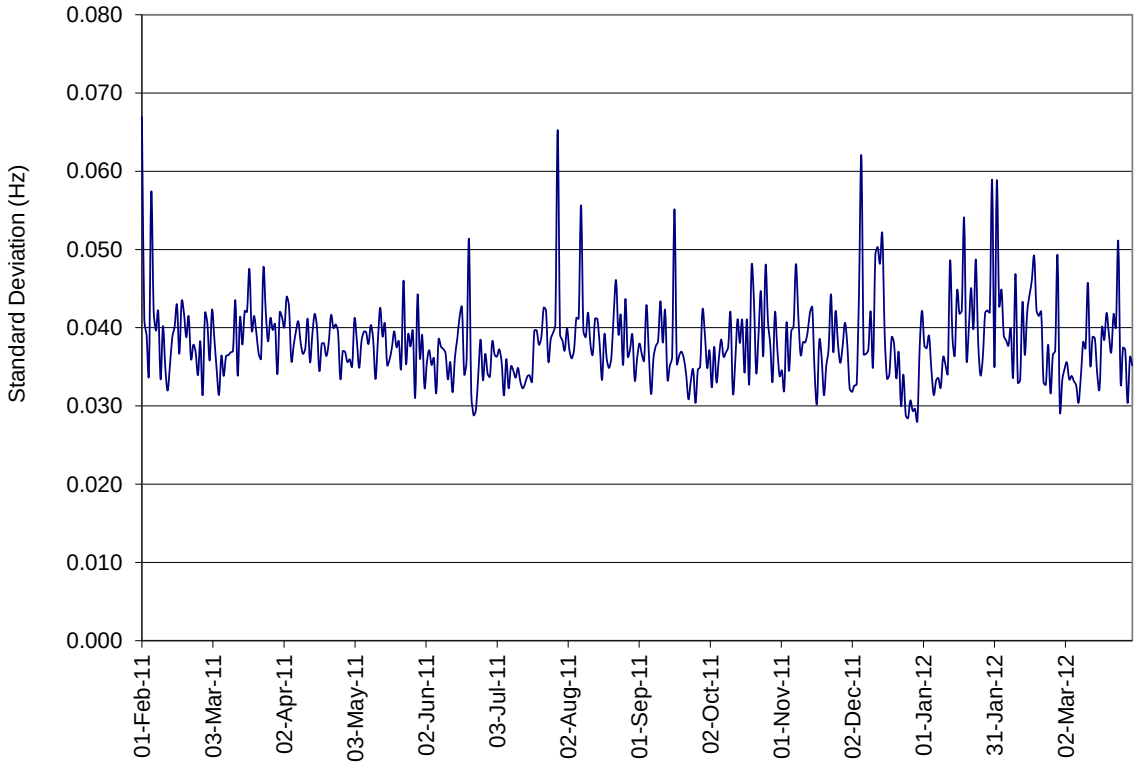


*Figure 6: Daily standard deviation of frequency in Tasmania.*

### 5.1.2 Time of day Analysis

This section details the standard deviation of system frequency on a monthly and daily basis. Figure 7 and Figure 8 show the average half-hourly standard deviation of the Mainland regions and Tasmania frequency for January 2011, February and March 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 7 and Figure 8 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).

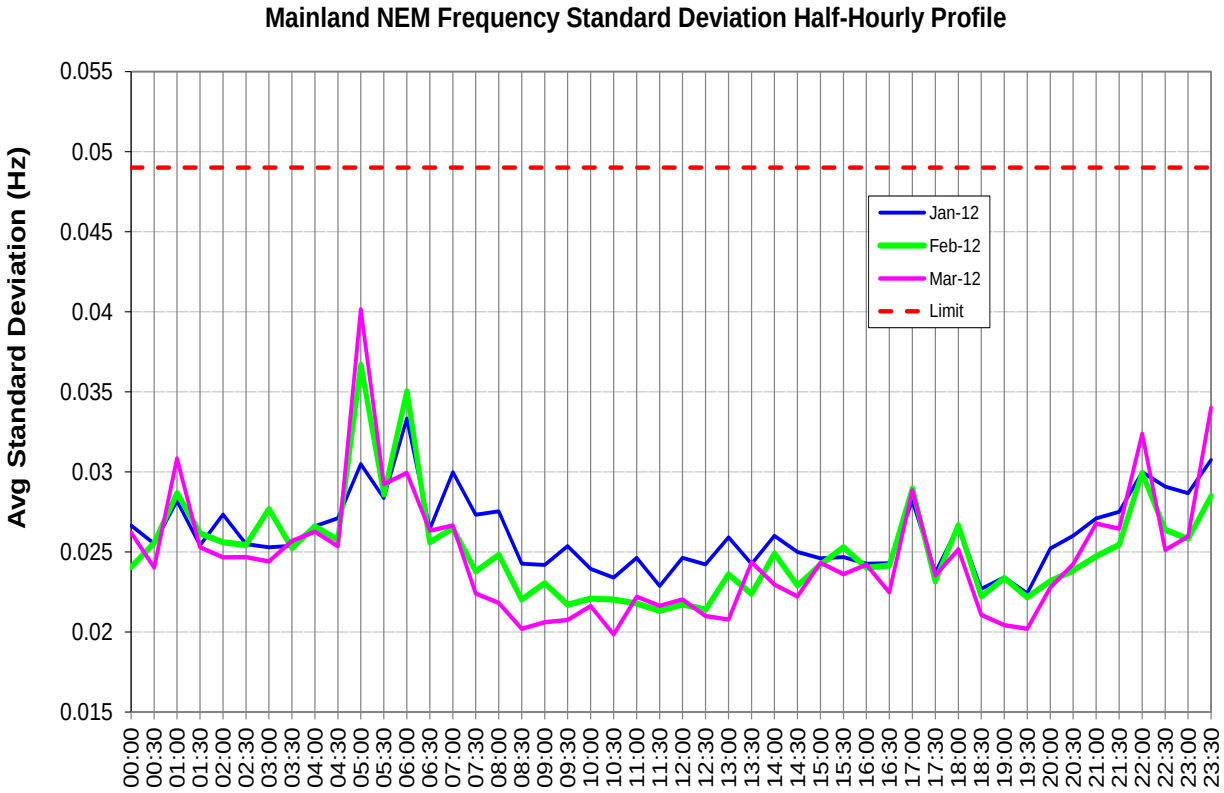


*Figure 7: Daily profile of standard deviation for the frequency in the Mainland regions.*

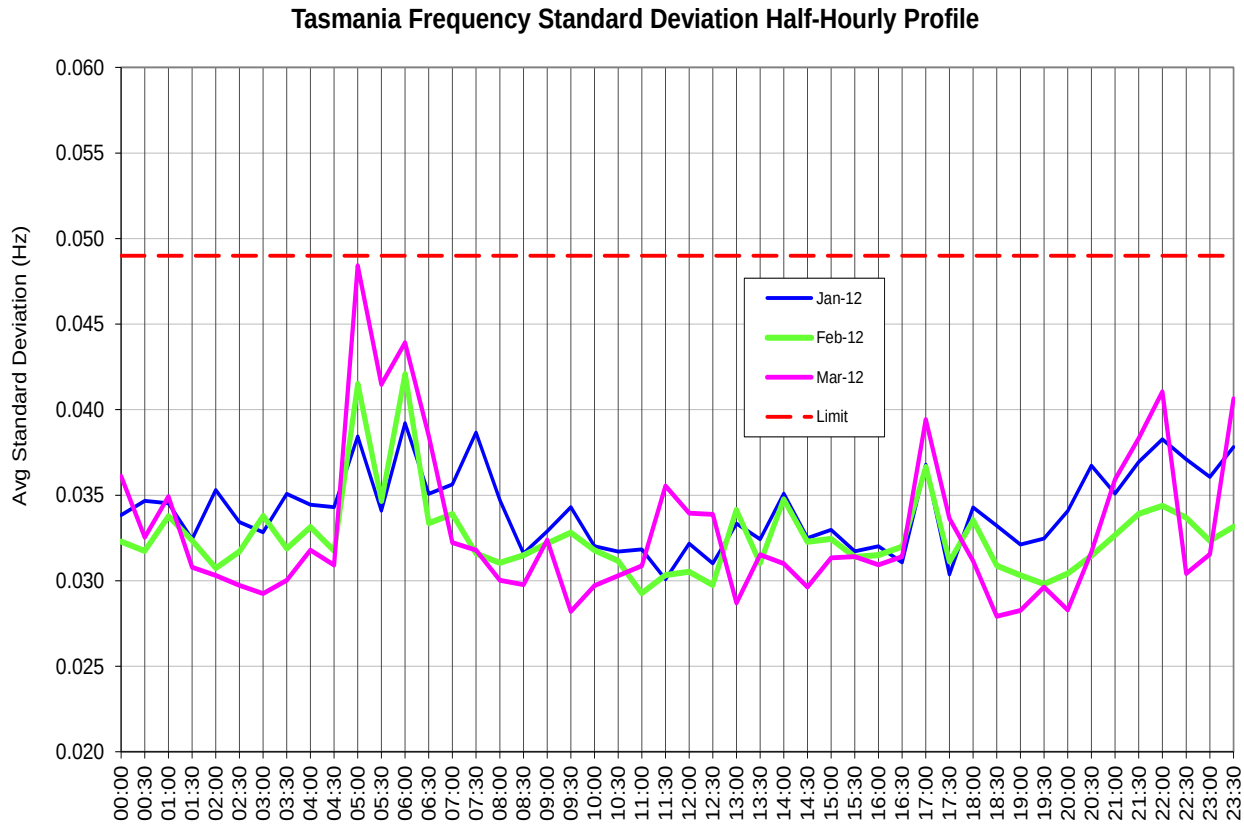


*Figure 8: Daily profile of standard deviation for the frequency in Tasmania.*

# 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 March 2012 is provided in Table 1.

*Table 3: Accumulated time deviation statistics*

| | QLD | NSW | VIC | SA | TAS |
|---|---|---|---|---|---|
| Maximum Positive Deviation (s) | 1.75 | 2.21 | 1.32 | 1.15 | 3.55 |
| Maximum Negative Deviation (s) | -3.02 | -2.91 | -3.46 | -3.62 | -5.77 |
| Mean Value (s) | -0.276 | 0.038 | -0.714 | -0.873 | -0.488 |
| Standard Dev (s) | 0.580 | 0.579 | 0.581 | 0.580 | 1.410 |

The distribution of time deviations based on the Mainland regions measurement is provided in Figure 9.

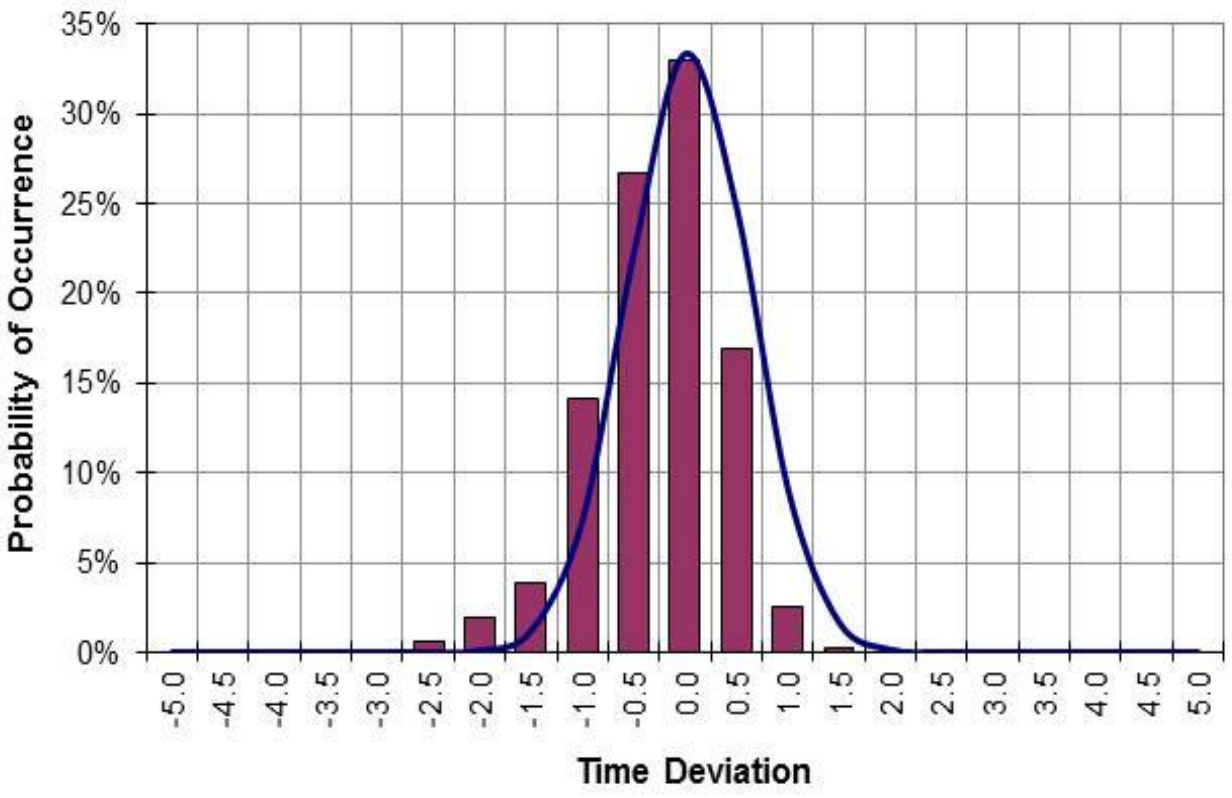


*Figure 9: Mainland time deviation distribution for March 2012.*

The distribution of time deviations based on the Tasmania region measurement is provided below in Figure 10.

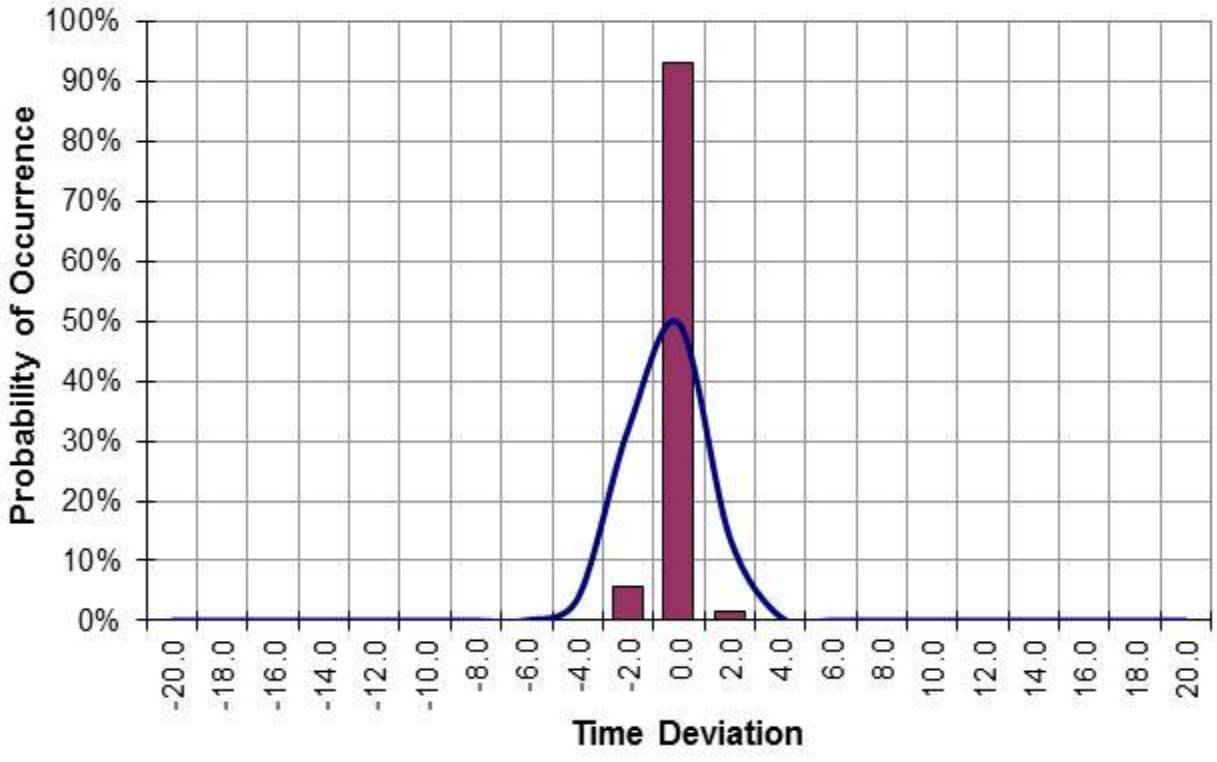


*Figure 10: Tasmania time deviation distribution for March 2012.*

## 6.1 Time Error Performance

Figure 11 below presents the daily maximum and minimum values of the Mainland regions time error observed for the past 13 months.

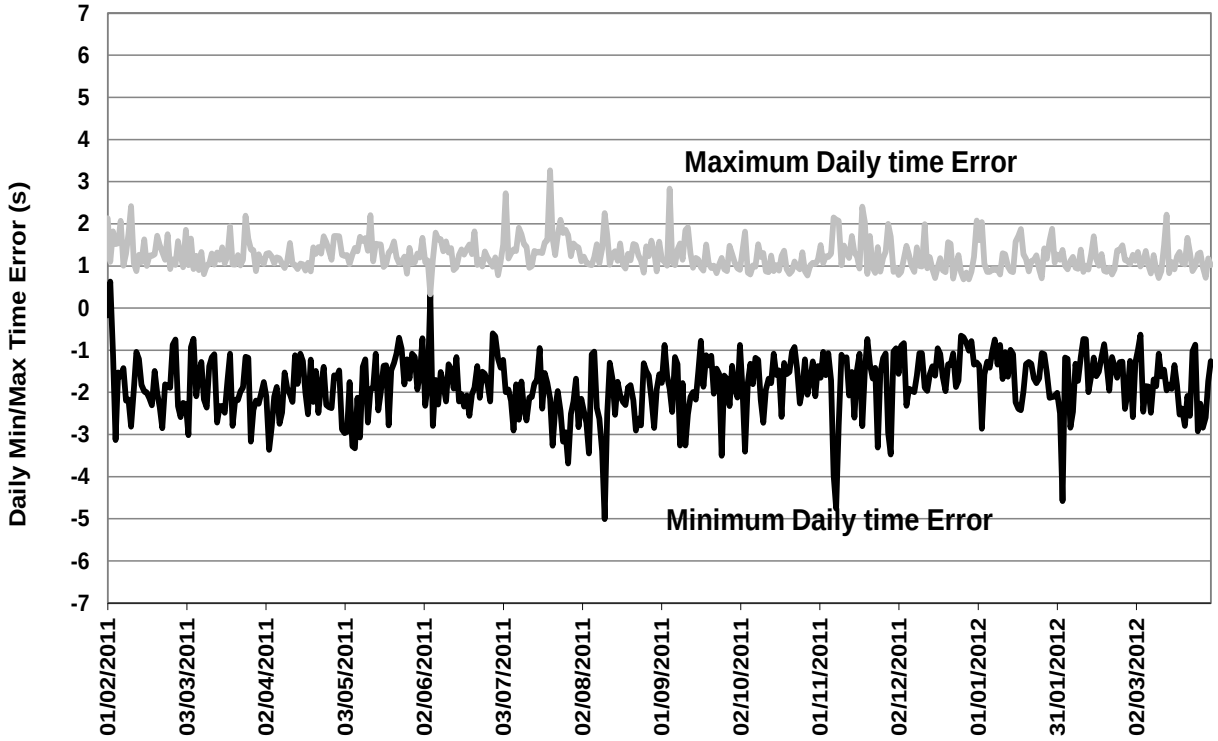


*Figure 11: Mainland regions daily maximum and minimum time deviation.*

Figure 12 below presents the daily maximum and minimum values of Tasmania time error observed for the past 13 months.

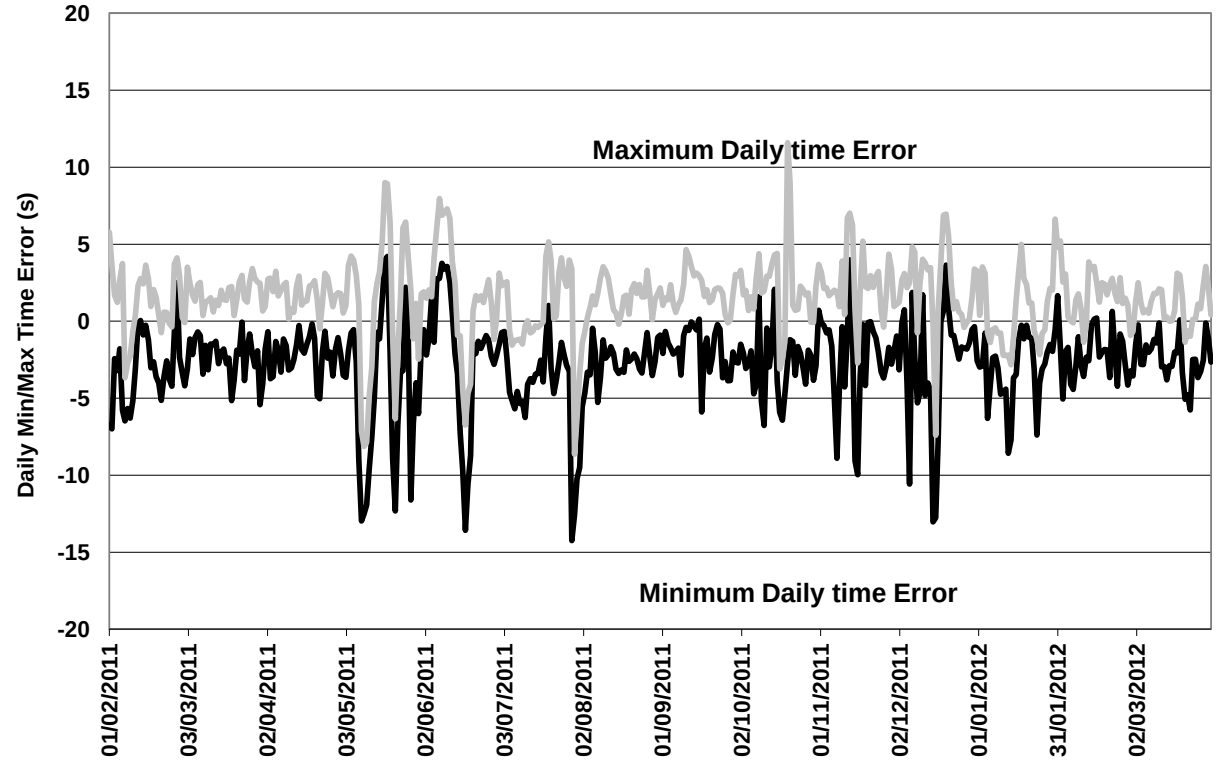


*Figure 12: Tasmania daily maximum and minimum time deviation.*