

# POWER SYSTEM OPERATING INCIDENT REPORT – VICTORIA/SOUTH AUSTRALIA REGIONAL SEPARATION 13 DECEMBER 2012

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FINAL

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## Abbreviations and Symbols

Abbreviation	Term
CB	Circuit Breaker
DI	Dispatch Interval
EMMS	Electricity Market Management System
EMS	Energy Management System
FCAS	Frequency Control Ancillary Service
kV	Kilovolt
LOR	Lack of Reserve
MW	Megawatt
NER	National Electricity Rules

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## Incident summary

<b>Date and time of incident</b>	0707 hrs 13 December 2012
<b>Region of incident</b>	Victoria
<b>Affected regions</b>	Victoria and South Australia
<b>Event type</b>	OTH – Other
<b>Primary cause</b>	TE – Transmission Equipment failure
<b>Impact</b>	Nil
<b>Associated reports</b>	Nil

## 1 Introduction

At 0707 hrs 13 December 2012, protection on the shunt reactor neutral reactor on the Alcoa Portland – Heywood Terminal Station No. 2 500 kV Transmission Line operated during planned switching of the line. The protection operation resulted in the separation of the South Australia and Victoria regions. There was no loss of generation and no interruption of supply to load in relation to this incident.

This report has been prepared under clause 4.8.15 (c) of the National Electricity Rules (NER) to assess the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security.

This report is largely based upon information provided by Alcoa and SP AusNet<sup>1</sup>. Data from AEMO's Energy Management System (EMS) and Electricity Market Management System (EMMS) has also been used in analysing the incident.

All references to time in this report are to National Electricity Market time (Australian Eastern Standard Time).

## 2 Pre-Contingent System Conditions

At 0743 hrs 12 December, AEMO issued Market Notice 40648, advising the market of a planned outage of the Alcoa-Portland – Heywood No. 2 500 kV Transmission Line. Market Notice 40648 also advised that during this outage, a credible contingency could result in the separation of the South Australia region from the Victoria region, with potential under-frequency load shedding in South Australia. An actual Lack of Reserve (LOR) condition was to be advised at the time of dispatch. At 0700 hrs 13 December 2012, AEMO gave SP AusNet Permission To Proceed with switching for a planned outage of the Alcoa Portland – Heywood No. 2 500 kV Transmission Line. The switching sequence mandated by AEMO was such that a credible contingency would not result in Alcoa Portland being supplied from the South Australia region.

The events leading up to the incident are shown in Table 1.

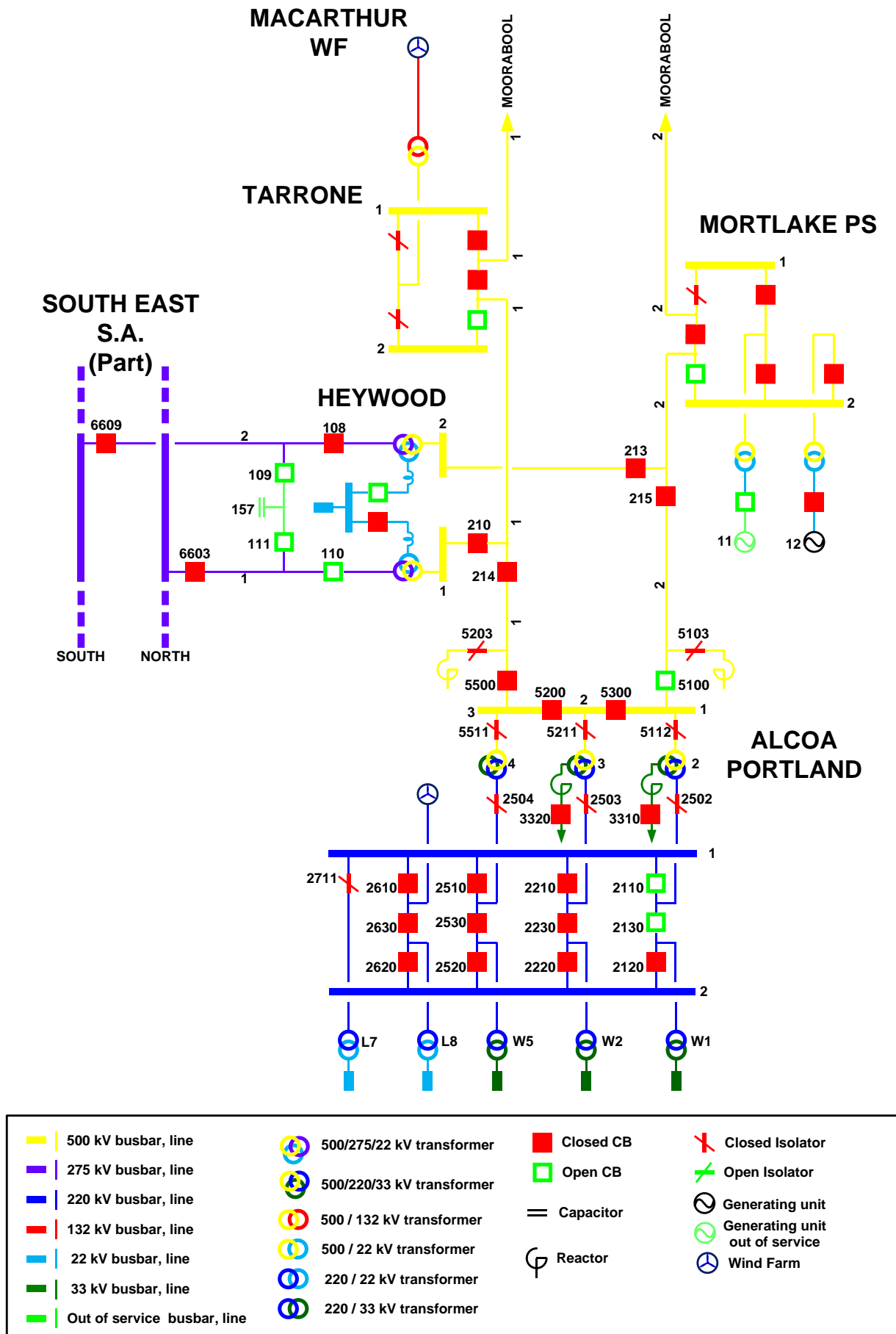
*Table 1: Events immediately prior to the incident at 0707 hrs 13 December 2012*

Time	Event
0700 hrs 13 December 2012	Permission To Proceed with switching Alcoa Portland – Heywood Terminal Station No. 2 500 kV Transmission Line out of service. Constraint sets F-I-HYSE, F-V-APHY_ONE, I-HYSE, V-APHY2, V-HYTX invoked.
0702 hrs 13 December 2012	500 kV CB 110 at Heywood Terminal Station opened.
0702 hrs 13 December 2012	500 kV CB Busbar 2 – Heywood Terminal Station line No.2 at Mortlake Power Station opened
0703 hrs 13 December 2012	500 kV CB Busbar 2 – Heywood Terminal Station line No.1 at Tarrone Terminal Station opened
0704 hrs 13 December 2012	220 kV CB 2110 at Alcoa Portland opened
0704 hrs 13 December 2012	220 kV CB 2130 at Alcoa Portland opened
0707 hrs 13 December 2012	500 kV CB 5100 at Alcoa Portland opened

Prior to the incident, the flow on the Victoria to South Australia interconnector was 152 MW to the South Australia region. The status of the power system prior to the incident is shown in Figure 1. For clarity only equipment relevant to this incident has been included in the diagram.

<sup>1</sup> Information provided by SP AusNet has been provided on a without prejudice basis and nothing in this report is intended to constitute, or may be taken by any person as constituting, an admission of fault, liability, wrongdoing, negligence, bad faith or the like on behalf of SP AusNet (or its respective companies, businesses, directors, officers or employees).

Figure 1 - Status of the power system prior to the incident at 0707 hrs 13 December 2012



### 3 Summary of Events

At 0707 hrs 13 December 2012, protection on the shunt reactor neutral reactor on the Alcoa Portland – Heywood Terminal Station No. 2 500 kV Transmission Line operated during planned switching of the line. The protection operated to remotely trip 500 kV CB 213 at Heywood Terminal Station and 500 kV CB Heywood Terminal Station line No.2 – Moorabool line No. 1 at Mortlake Power Station. As a result of these trips, the South Australia and Victoria regions separated at Heywood Terminal Station. The Alcoa Portland Aluminium Smelter received supply from the Victoria region. An inspection immediately after the trip revealed that the surge arrester located between the line reactor and the neutral reactor on the Alcoa Portland – Heywood Terminal Station No. 2 500 kV Transmission Line had suffered catastrophic thermal failure. The events during the incident are summarised in Table 2.

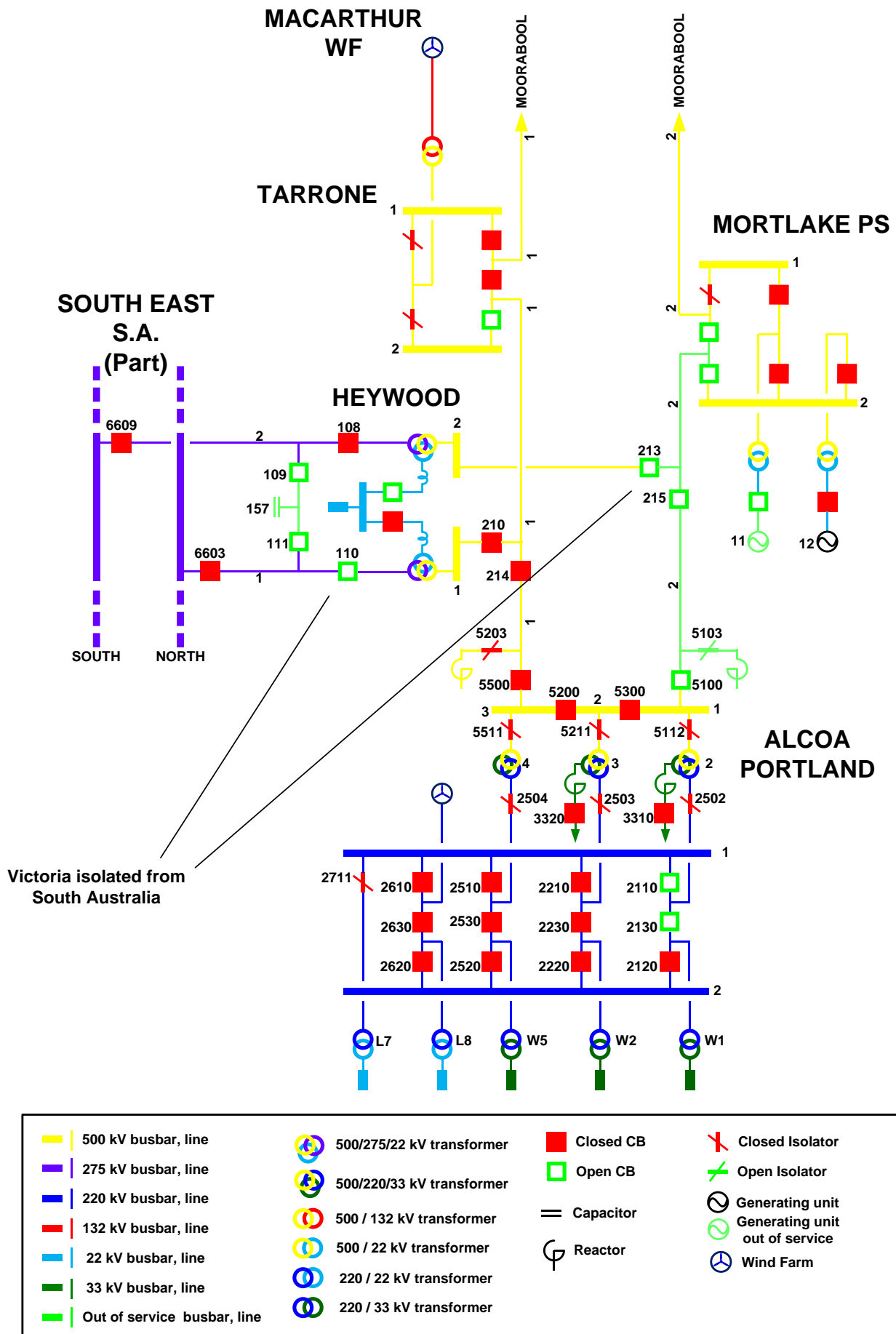
*Table 2: Event during incident at 0707 hrs 13 December 2012*

Time	Event
0707 hrs 13 December 2012	500 kV CB 215 at Heywood Terminal Station opened.
0707 hrs 13 December 2012	500 kV CB 213 at Heywood Terminal Station trips. South Australia and Victoria separated, approximately 22 seconds after CB 215 opened.
0708 hrs 13 December 2012	500 kV CB connecting Heywood Terminal Station line No.2 and Moorabool line No.2 at Mortlake Power Station trips, approximately 23 seconds after CB 215 opened.

The status of the power system immediately after the incident is shown in Figure 2.



Figure 2 - Status of the power system immediately after the incident



## 4 Immediate Actions Taken

The 500 kV isolator 5103 at Alcoa Portland was immediately opened to isolate the failed reactor and allow restoration of the Alcoa Portland – Heywood Terminal Station No.2 500 kV Transmission line. AEMO invoked constraints sets F-ESTN\_ISLE, F-SA\_ESTN\_ISLE\_REG, F-SA\_ISLE and SA\_ESTN\_ISLE in the DI ending 0715 hrs. From 0714 hrs to 0721 hrs, switching was carried out to re-synchronise the South Australia and Victoria regions. Synchronisation occurred at 0721 hrs.

AEMO revoked constraints sets F-ESTN\_ISLE, F-SA\_ESTN\_ISLE\_REG, F-SA\_ISLE and SA\_ESTN\_ISLE in the DI ending 0725 hrs. At 0741 hrs, AEMO issued Market Notice 40663, advising the market of the incident.

The immediate actions after the incident are summarised in Table 3.

Table 3: Actions immediately after the incident at 0707 hrs 13 December 2012

Time	Event
0707 hrs 13 December 2012	500 kV isolator 5103 at Alcoa Portland opened.
0710 hrs 13 December 2012	Constraint sets F-ESTN_ISLE, F-SA_ESTN_ISLE_REG, F-SA_ISLE and SA_ESTN_ISLE invoked.
0714 hrs 13 December 2012	500 kV CB 5300 at Alcoa Portland opened, to allow access to inspect failed reactor in Alcoa switchyard.
0715 hrs 13 December 2012	500 kV CB Heywood line No.2 – Moorabool line No.2 at Mortlake Power Station closed.
0716 hrs 13 December 2012	275 kV CB 108 at Heywood Terminal Station opened
0716 hrs 13 December 2012	500 kV CB 213 at Heywood Terminal Station closed
0718 hrs 13 December 2012	275 kV CB 6609 at South East opened
0719 hrs 13 December 2012	275 kV CB 108 at Heywood Terminal Station closed
0721 hrs 13 December 2012	275 kV CB 6609 <sup>2</sup> at South East closed. Victoria and South Australia regions synchronised.
0741 hrs 13 December 2012	Market Notice 40663 issued, advising the market of the incident.

## 5 Follow-up Actions

Inspection of high speed measurements at Heywood Terminal Station show there was current on the red phase of the Alcoa Portland – Heywood Terminal Station No.2 500 kV Transmission Line, following the switching of 500 kV CB 215 at Heywood Terminal Station at 0707 hrs. The failure of the red phase to open correctly left one phase of the shunt reactor energised, resulting in a voltage rise across and current through the neutral reactor. The sustained excess voltage caused the surge arrester to thermally fail. The prolonged current resulted in overcurrent protection operation approximately 22 seconds after the red phase failed to open.

The 500 kV CB 215 at Heywood Terminal Station was subsequently inspected by SP AusNet personnel, who were unable to detect a cause for the circuit breaker failing to open on red phase. The circuit breaker was found open on all phases and there was no phase discrepancy alarms indicated for Heywood Terminal Station. The 500 kV CB 215 at Heywood Terminal Station remains under investigation by SP AusNet.

The surge arrester and neutral reactor on Alcoa Portland – Heywood Terminal Station No.2 500 kV Transmission Line was repaired and returned to service by 24 February 2013.

<sup>2</sup> 275 kV CB 6609 has synchronising capability.

## 6 Power System Security Assessment

The separation of the South Australia and Victoria regions was a credible contingency event, for the planned outage of the Alcoa Portland – Heywood No. 2 500 kV Transmission Line. The switching as mandated by AEMO was planned such that if an incident were to occur, the potlines at Alcoa Portland would be supplied from Victorian generation. This was because there may have been insufficient South Australian generation to supply Alcoa Portland as well as South Australia following regional separation.

The power system voltages and frequencies in the Victoria region and interconnected regions remained within the normal operating bands and the power system remained in a secure operating state throughout the incident.

As a result of the regional separation, the frequency in the South Australia region fell to a minimum of 49.4 Hz, as shown in Figure 3. No load shedding was observed in the South Australia region as a result of the regional separation. The provision of Fast, Slow and Delayed market ancillary services in the South Australia region was sufficient to return the frequency to the Normal Operating Frequency Band<sup>3</sup> within the times in the Mainland Frequency Operating Standard. The performance against the Mainland Frequency Operating Standard is summarised in Table 4.

Figure 3 – South Australia frequency during the incident at 0707 hrs 13 December 2012.

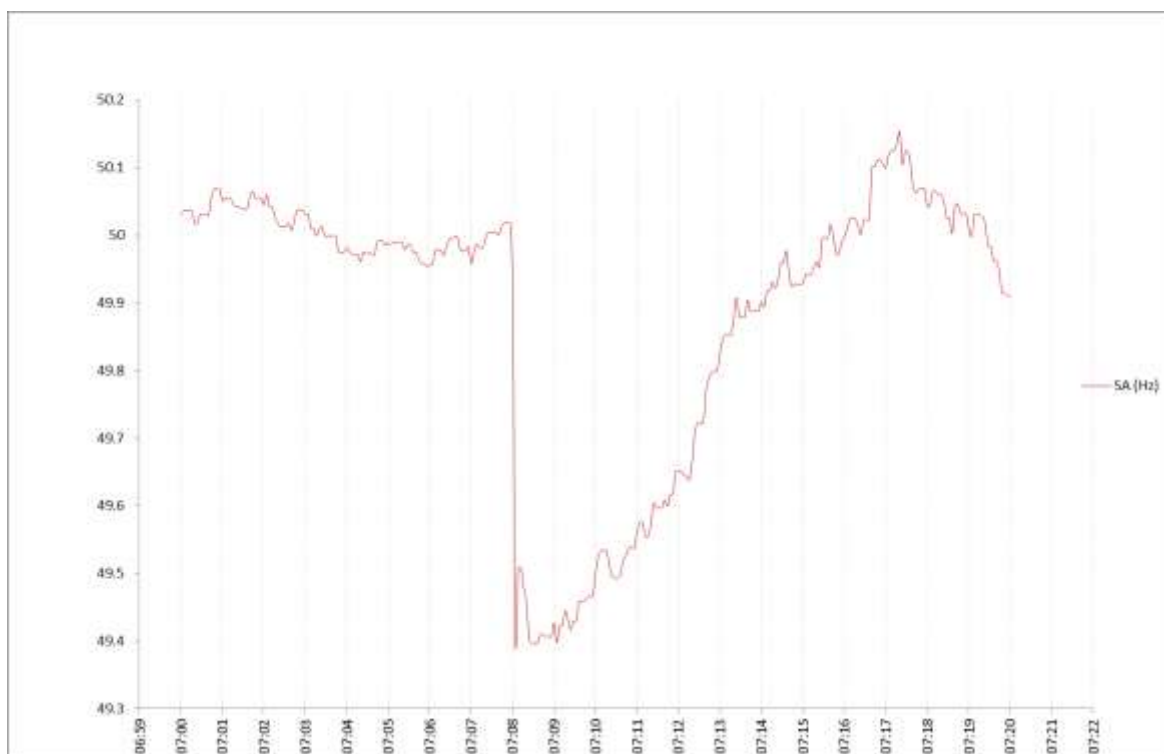


Table 4: South Australia frequency performance following incident at 0707 hrs, 13 December 2012.

Frequency recovery phase	Performance requirement in Frequency Operating Standard	Performance requirement observed in South Australia
Containment	49.0 to 51.0 Hz	Band not breached
Stabilisation	49.0 to 51.0 Hz within 2 minutes	Band not breached
Recovery	49.5 to 50.5 Hz within 10 minutes	49.5 to 50.5 Hz within 3 minutes

<sup>3</sup> Refer to the Frequency Operating Standards (Mainland) on the [AEMC website](#). Under interconnected system conditions the Normal Operating Frequency Band is 49.85 Hz – 50.15 Hz. Under islanded system conditions the Normal Operating Frequency Band is 49.5 Hz – 50.5 Hz.

Following the separation of the South Australia region from the Victoria region, there was a shortage of Fast and Delayed Raise market ancillary services in the South Australia region, to be able to recover the South Australia frequency following a subsequent loss of the largest generating unit in South Australia. Constraint sets F\_S+MG\_R6 and F\_S+MG\_5 violated during DIs ending 0720 hrs and 0725 hrs.

The provision and response of facilities and services were adequate to restore power system security. The power system was brought to a secure operating state within 14 minutes following occurrence of the incident. A LOR condition in South Australia was not declared by AEMO as the South Australia and Victoria regions were resynchronised in a timeframe before a Market Notice could be issued.

## **7 Conclusions**

The failure of the red phase on the 500 kV CB 215 at Heywood Terminal Station left of the Alcoa Portland – Heywood No. 2 500 kV line energised including the shunt reactor at Alcoa Portland. This resulted in a current flow in the shunt reactor neutral reactor and a voltage rise across the neutral reactor. The voltage rise caused the surge arrester to thermally fail. Overcurrent protection on the shunt reactor neutral reactor operated to separate the South Australia and Victoria regions.

AEMO is satisfied that SP AusNet shall carry out the appropriate work to mitigate the risk of a similar incident occurring in the future.

## **8 Recommendations**

SP AusNet shall complete their investigation of the 500 kV CB 215 at Heywood Terminal Station, and carry out all necessary work on the circuit breaker and associated plant. This shall be completed before 30 June 2013.