POWER SYSTEM OPERATING INCIDENT REPORT – INSECURE POWER SYSTEM OPERATION ON 19 OCTOBER 2011

PREPARED BY: Electricity System Operations Planning and Performance

DATE: 14 February 2012

FINAL

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Abbreviations and Symbols

Abbreviation	Term
AGC	Automatic Generation Control
CB	Circuit Breaker
FCAS	Frequency Control Ancillary Service
HYTS	Heywood Terminal Station
kV	Kilovolt
LOR	Lack of Reserve
MW	Megawatt
NEMDE	National Electricity Market Dispatch Engine
SESS	South East Substation

1 Introduction

On 19 October 2011, the Heywood Terminal Station (HYTS) M2 500/275 kV transformer and the South East Substation (SESS)–HYTS No.2 275 kV line tripped as a result of a malfunction of the line protection system. At the time of the event, the SESS–HYTS No.1 275 kV line was out of service for a planned outage. This resulted in the opening of the Victoria to South Australia 275 kV interconnection (Heywood interconnector). South Australia remained electrically connected to the Victoria region via Murraylink interconnector. There was no loss of supply or generation as a result of this incident.

This report has been prepared under clause 4.8.15 of the National Electricity Rules 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 SP AusNet and AEMO.

All references to time in this report refer to Market time (Australian Eastern Standard Time).

2 Pre-Contingent System Conditions

The HYTS M1 500/275 kV transformer was planned out of service over the period from 17 October 2011 to 21 October 2011. On 14 October 2011, AEMO published Market Notice 36328 indicating that due to planned network outages in the Victorian region, a credible contingency event could result in the South Australian region separating from the rest of the mainland interconnected power system, which could also lead to automatic under frequency load shedding in South Australia. The market notice further advised participants of forecast Lack of Reserve Level 2 (LOR2)1 condition for the South Australian region from 17 October 2011 to 21 October 2011. Over the period for which the LOR2 condition was declared, there was sufficient capacity reserves in the South Australian region but the technical characteristics of the capacity reserve plant that was off line was such that they could not return to service within the required time.

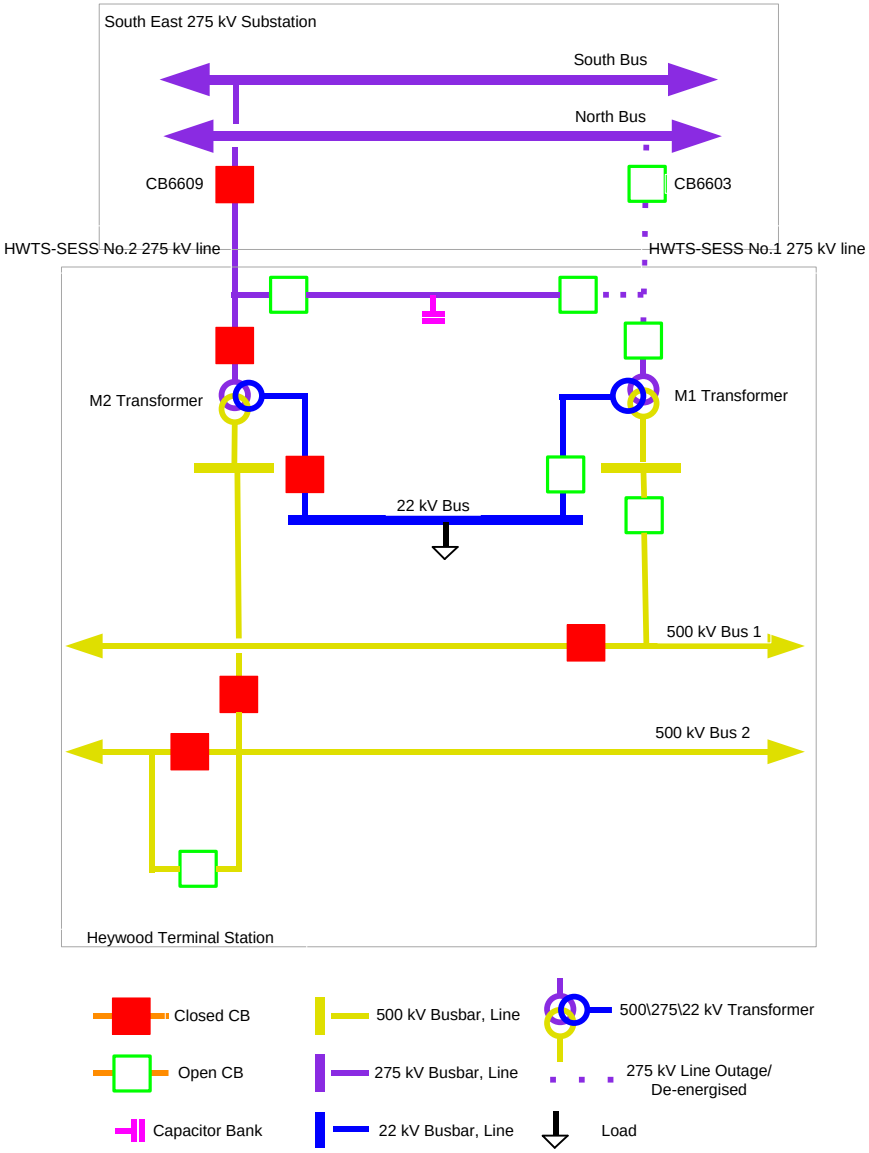
A planned outage of the SESS–HYTS No.1 275 kV line had commenced earlier in the day.

The status of the power system prior to the incident is shown in Figure 1 below. For clarity only equipment relevant to this incident has been included in the diagram.

Prior to separation, the South Australian system demand was approximately 1562 MW. There was approximately 917 MW of wind generation and 754 MW of thermal generation in South Australia. Interconnector flow on the Heywood interconnector was 15 MW into South Australia and on the Murraylink interconnector was 124 MW into Victoria.

[1] LOR2 is declared when AEMO considers that the occurrence of the credible contingency event which has the potential for the most significant impact on the power system is likely to require involuntary load shedding. This would generally be the instantaneous loss of the largest generating unit on the power system. Alternatively, it might be the loss of any interconnection under abnormal conditions. Refer to clause 4.8.4(c) of the Rules for more information.

Figure 1 – Status of the power system prior to the incident

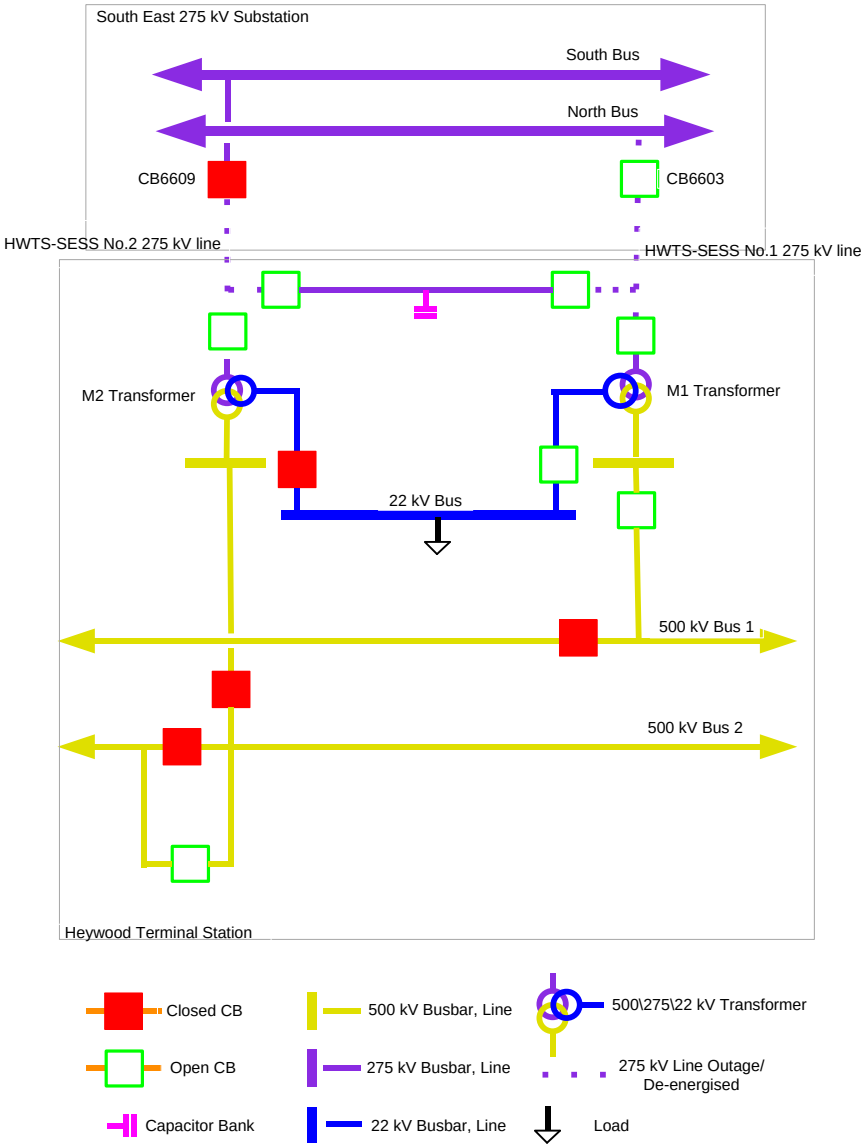


3 Summary of Events

At 0618 hrs on 19 October 2011, the SESS–HYTS No.2 275 kV line opened at HYTS due to malfunction of its line protection. The 500/275 kV M2 transformer at HYTS was off-loaded as a consequence. These events led to the opening of the Heywood interconnector. The SESS–HYTS No.2 275 kV line remained energised from SESS.

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

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



4 Immediate Actions Taken

At 0620 hrs, AEMO reconfigured its Automatic Generation Control systems (AGC)[2] to manage the islanded South Australian system frequency separately to the other mainland regions.

At 0625 hrs, AEMO invoked the South Australia separation constraint sets [3](SA_ESTN_ISLE, F-SA_ISLE, F-SA_ESTN_ISLE_REG, F-ESTN_ISLE).

At 0630 hrs, SP AusNet manually opened the circuit breaker CB 6609 at SESS de-energising the SESS–HYTS No.2 275 kV line to enable field staff to investigate the reason for the line and transformer trip.

[2] AGC serves two purposes:

- Energy market dispatch of generating units: Generating units are ramped to their dispatch targets.
- Frequency regulation: Units enabled for frequency control ancillary services (FCAS) are dispatched away from their energy market dispatch to control frequency and time error to desired values.

[3] The separation constraint sets contain constraint equations used by AEMO to determine the amount of FCAS required for each of the 8 FCAS services. Constraints are used to specify global requirements, local requirements for one or more regions, and for co-optimisation of local FCAS requirements against interconnector flow in the event of the interconnector being declared a credible contingency risk. Refer to http://www.aemo.com.au/electricityops/160-0272.html .

At 0631 hrs, AEMO issued Market Notice 36379 advising the opening of the Heywood interconnector at HYTS.

At 0645 hrs, SP AusNet identified the line trip was caused by a blown fuse on the Capacitor Voltage Transformer (CVT) blue phase Y protection secondary circuit of the SESS–HYTS No.2 275 kV line.

At 0647 hrs, SP AusNet replaced the fuse and the SESS–HYTS No.2 275 kV line and the HYTS M2 500/275 kV transformer were energised at HYTS.

At 0648 hrs, AEMO gave ElectraNet permission to re-synchronise South Australia.

At 0653 hrs, South Australian power system was re-synchronised at HYTS via the SESS–HYTS No.2 275 kV line.

At 0657 hrs, AEMO restored normal operation of the AGC.

At 0659 hrs, Market Notice 36380 was issued advising of the re-synchronisation of South Australia.

At 0700 hrs, AEMO revoked the South Australia separation constraint sets.

5 Follow-up Actions

SP AusNet advised that same fuse also blew on 26 July 2011. Initial checks carried out SP AusNet on the CVT wiring and connections did not identify any wiring faults.

SP AusNet has scheduled further checks on the CVT wiring and connections along with simulation tests before a detailed plan for corrective action is determined. A mitigation strategy will be planned after completion of these investigations scheduled to be completed by the end of April 2012.

6 Power System Security Assessment

6.1 Power System Excluding South Australia

The voltages and frequency of mainland power system excluding the South Australia remained within the normal operating bands and remained in a secure operating state throughout the incident.

There was no loss of supply or generation as a result of this incident.

6.2 South Australia

The trip of the SESS–HYTS No.2 275 kV line and HYTS M2 transformer resulted in the opening of the Heywood interconnector. South Australia remained electrically connected to the Victoria region via Murraylink interconnector.

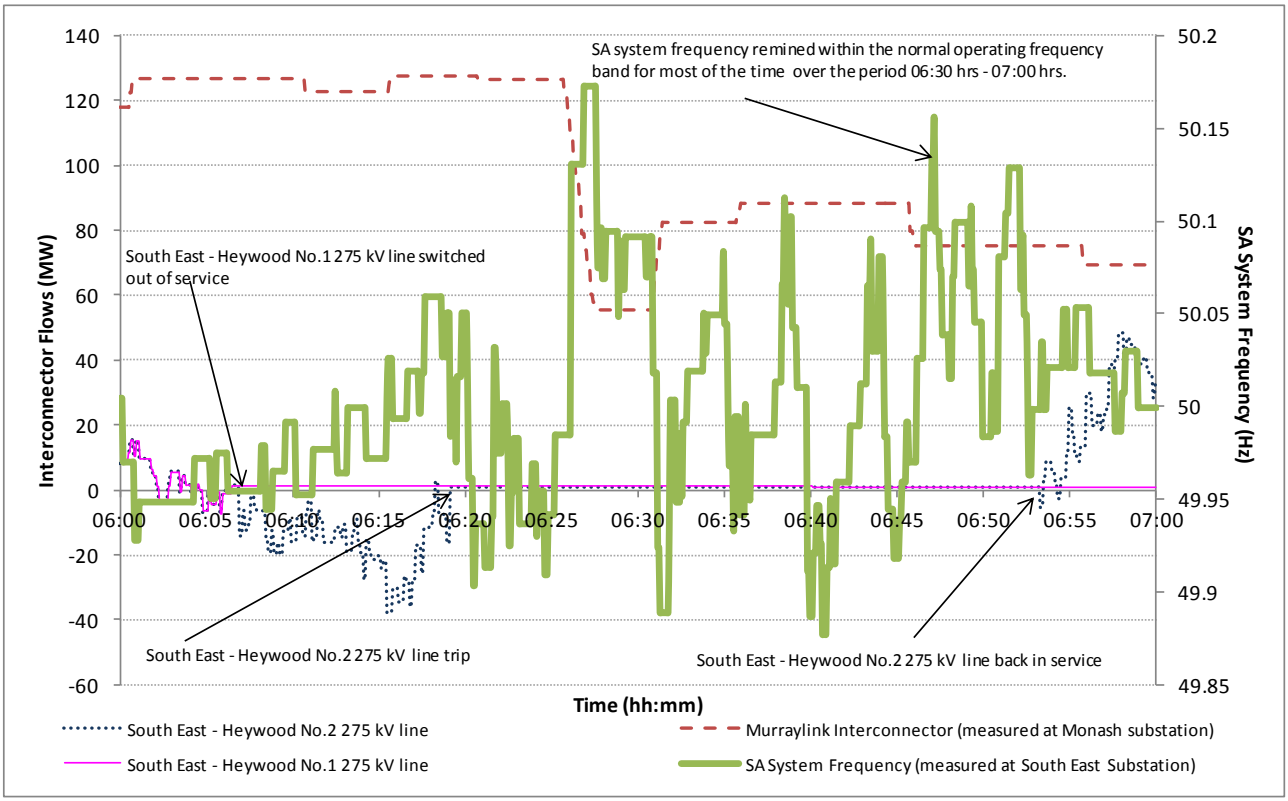
Throughout the separation, the voltage in South Australia remained within the normal operating range.

The applicable frequency standard[4], as notified by the Jurisdictional Coordinator[5], for separation of South Australia is 47 Hz to 52 Hz. As shown in Figure 3 below, the applicable frequency standard was met.

[4] The frequency operating standards for the mainland and Tasmania regions are available at: http://www.aemc.gov.au/Panels-and-Committees/Reliability-Panel/Guidelines-and-standards.html.

[5] The Jurisdictional co-coordinator for South Australia has notified AEMO that the frequency band for separation of the South Australian power system is 47 Hz to 52 Hz. Refer to Operating Procedure – Frequency Control Ancillary Services SO-OP3708A for more details http://www.aemo.com.au/electricityops/3708.html.

Figure 23 South Australia System Frequency, Heywood & Murraylink Interconnector Flows



A number of the FCAS constraint equations invoked to manage the separation violated, indicating there was insufficient FCAS available over the period from 0630 hrs to 0700 hrs in the islanded South Australian system (See Appendix A). This was because of the relatively high proportion of wind generation compared to thermal generation in South Australia at the time. The possibility of not having sufficient FCAS during the outage of Heywood M1 transformer was not assessed at the time of conducting the outage assessment.

Despite this, the low level of power transfer to South Australia on the Heywood interconnector at the time of the separation (around 15 MW) coupled with Murraylink reducing power transfer from South Australia to Victoria immediately after the event aided the South Australian system frequency to remain within the normal operating frequency band of 49.5 Hz – 50.5 Hz (for islands) for most of the time over the period from 0618 hrs to 0700 hrs.

From 0630 hrs to 0700 hrs, a credible contingency event such as a loss of the largest generation in South Australia would have resulted in frequency falling outside the applicable frequency operating standard, and as a result South Australia is considered to have not been in a secure operating state during this period.

At 0700 hrs, the Heywood interconnector was restored and the South Australian power system was returned to a secure operating state. As required by the Electricity Rule clause 4.2.6, AEMO took all reasonable actions in order to return the power system to a secure operating state within thirty minutes.

There was no loss of supply or generation in the islanded South Australian system as a result of this incident.

AEMO correctly applied the criteria published in sections 6.1.1.2 and 6.1.3 of its “Operating Procedure – SO_OP3708A Frequency Control Ancillary Services” in scheduling and dispatch of FCAS.

AEMO correctly managed the LOR condition declared for South Australia via Market Notice 36328 in accordance with procedures.

AEMO is satisfied that SP AusNet carried out the preliminary investigation of the incident, identified and rectified the cause of the fault and restored the Heywood interconnector in a timely manner.

7 Conclusions

At 0618 hr on 19 October 2011, the SESS – HYTS No.2 275 kV line opened at HYTS and the HYTS M2 transformer tripped due to a malfunction of the SESS – HYTS No.2 275 kV line protection during a planned outage of the SESS – HYTS No.1 275 kV line. This resulted in the opening of the Heywood interconnector. South Australia remained electrically connected to the Victoria region via Murraylink interconnector.

Over the period of separation South Australian power system frequency and voltages remained within the normal operating range. However, insufficient FCAS availability meant that the South Australian power system was not in a secure operating state from 0630 hrs to 0700 hrs.

In the pre-dispatch timeframe, AEMO correctly applied the criteria published in its procedures covering the scheduling and dispatch of FCAS, operation of low capacity interconnectors and the control of power system frequency, and in the management of reserve conditions.

This incident highlighted the need to assess FCAS requirements in the as part of the outage assessment process[6].

As required by the Electricity Rule clause 4.2.6, AEMO took all reasonable actions in order to return the South Australian power system to a secure operating state within thirty minutes.

AEMO is satisfied that SP AusNet carried out the initial the investigation of this incident and took appropriate action to address the cause of the fault. SP AusNet is undertaking further action to remove the risk of repeat of the same event.

8 Recommendations

1. SP AusNet notify AEMO of the outcome of its simulation based tests and investigation on the operation of CVT wiring and the mitigation strategies available to minimise the risk of similar failures in future. SP AusNet has advised it will complete this action by 30 April 2012.
2. AEMO will review its outage assessment process to improve the method of assessing whether the FCAS requirements at times of high wind generation in South Australia whenever outages of the elements of Heywood interconnector are scheduled over extended periods. AEMO will complete this action by 30 June 2012.

[6] Outage assessment takes place a few days before the commencement of the outage.

Appendix A FCAS Violations

Dispatch Interval	Type of FCAS[7] Service	Violated FCAS Constraints	Scheduled FCAS (MW)	Calculated FCAS Requirement (MW)
6:30	R5	F_S+MG_R5	0	117
6:30	R6	F_S+MG_R6	47	98
6:30	R60	F_S+MG_R60	90	98
6:30	RREG	F_S+RREG_0070	10	70
6:30	L5	F_S+TL_L5_OD	0	128
6:30	L60	F_S+TL_L60_OD	90	109
6:30	L6	F_S+TL_L6_OD	47	109
6:30	LREG	F_S+LREG_0070	35	70
6:35	R5	F_S+MG_R5	50	139
6:35	R6	F_S+MG_R6	47	119
6:35	R60	F_S+MG_R60	90	119
6:35	RREG	F_S+RREG_0070	20	70
6:35	L5	F_S+TL_L5_OD	9	129
6:35	L60	F_S+TL_L60_OD	90	109
6:35	L6	F_S+TL_L6_OD	47	109
6:35	LREG	F_S+LREG_0070	53	70
6:40	R5	F_S+MG_R5	50	149
6:40	R6	F_S+MG_R6	47	129
6:40	R60	F_S+MG_R60	90	129
6:40	RREG	F_S+RREG_0070	48	70
6:40	L5	F_S+TL_L5_OD	11	128
6:40	L60	F_S+TL_L60_OD	90	108
6:40	L6	F_S+TL_L6_OD	47	108
6:40	LREG	F_S+LREG_0070	56	70
6:45	R5	F_S+MG_R5	50	161
6:45	R6	F_S+MG_R6	55	141
6:45	R60	F_S+MG_R60	82	141
6:45	RREG	F_S+RREG_0070	69	70
6:45	L5	F_S+TL_L5_OD	28	128
6:45	L60	F_S+TL_L60_OD	96	107
6:45	L6	F_S+TL_L6_OD	58	107
6:50	R5	F_S+MG_R5	35	166
6:50	R6	F_S+MG_R6	56	145
6:50	R60	F_S+MG_R60	84	145
6:50	L5	F_S+TL_L5_OD	45	133

[7] FCAS consists of eight FCAS services namely: Regulation Raise (RREG), Regulation Lower(LREG), Fast Raise(R6), Fast Lower(L6), Slow Raise(R60), Slow Lower(L60), Delayed Raise (R5) and Delayed Lower(L5).

Dispatch Interval	Type of FCAS[7] Service	Violated FCAS Constraints	Scheduled FCAS (MW)	Calculated FCAS Requirement (MW)
6:50	L60	F_S+TL_L60_OD	99	112
6:50	L6	F_S+TL_L6_OD	59	112
6:55	R5	F_S+MG_R5	38	176
6:55	R6	F_S+MG_R6	54	155
6:55	R60	F_S+MG_R60	85	155
6:55	L5	F_S+TL_L5_OD	42	134
6:55	L60	F_S+TL_L60_OD	107	112
6:55	L6	F_S+TL_L6_OD	59	112
7:00	R5	F_S+MG_R5	34	188
7:00	R6	F_S+MG_R6	54	166
7:00	R60	F_S+MG_R60	85	166
7:00	L5	F_S+TL_L5_OD	46	134
7:00	L60	F_S+TL_L60_OD	108	112
7:00	L6	F_S+TL_L6_OD	59	112