

POWER SYSTEM OPERATING INCIDENT REPORT INSECURE POWER SYSTEM OPERATION ON 4 OCTOBER 2011

PREPARED BY: Electricity System Operations Planning and Performance

VERSION: 4.0

DATE: 2 February 2012

FINAL

Disclaimer

Purpose

This report has been prepared by the Australian Energy Market Operator Limited (**AEMO**) for the sole purpose of meeting obligations in accordance with clause 4.8.15 (c) of the National Electricity Rules.

No reliance or warranty

This report contains data provided by third parties and might contain conclusions or forecasts and the like that rely on that data. This data might not be free from errors or omissions. While AEMO has used due care and skill, AEMO does not warrant or represent that the data, conclusions, forecasts or other information in this report are accurate, reliable, complete or current or that they are suitable for particular purposes. You should verify and check the accuracy, completeness, reliability and suitability of this report for any use to which you intend to put it, and seek independent expert advice before using it, or any information contained in it.

Limitation of liability

To the extent permitted by law, AEMO and its advisers, consultants and other contributors to this report (or their respective associated companies, businesses, partners, directors, officers or employees) shall not be liable for any errors, omissions, defects or misrepresentations in the information contained in this report, or for any loss or damage suffered by persons who use or rely on such information (including by reason of negligence, negligent misstatement or otherwise). If any law prohibits the exclusion of such liability, AEMO's liability is limited, at AEMO's option, to the re-supply of the information, provided that this limitation is permitted by law and is fair and reasonable.

Abbreviations and Symbols

Abbreviation	Term
AEMO	Australian Energy Market Operator Ltd
APD	Alcoa/Portland
CVP	Constraint Violation Penalty
DI	Dispatch Interval
EMS	Energy Management System
FCAS	Frequency Control Ancillary Service
HYTS	Heywood Terminal Station
kV	Kilovolt
MORTLK11	Mortlake Generating Unit No.1
MW	Megawatt
MOPS	Mortlake Power Station
NEMDE	National Electricity Market Dispatch Engine
NOS	Network Outage Schedule

1 Introduction

On 4 October 2011, the power system in South Australia was not operated in a secure operating state from 1015 hours to 1110 hours when Frequency Control Ancillary Service (FCAS) requirements in South Australia (SA) were not met. This was caused by the combination of commissioning tests on the new Mortlake Power Station Generating Unit No.1¹ during a planned outage of the APD – Heywood No.2 500 kV transmission line.

This report has been prepared under clause 4.8.15 (c) 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.

Information for this report has been provided by AEMO, Origin Energy, the owner of Mortlake Power Station and SP AusNet. Data from AEMO’s Energy Management System and Electricity Market Management System has also been used in analysing the incident.

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

2 Summary of Events

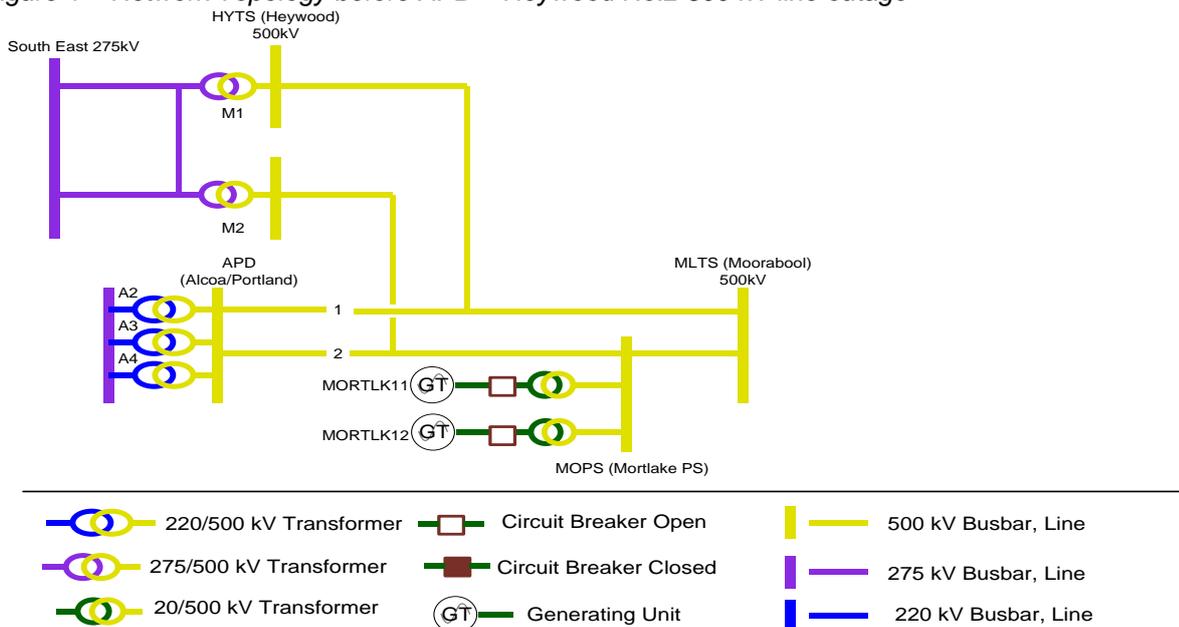
APD – Heywood No.2 500 kV line Outage:

At 0700 hours on 3 October 2011, a two day planned outage of the APD – Heywood No.2 500 kV line commenced. For this outage, AEMO’s power system operating procedures required the Heywood Terminal Station (HYTS) M2 500/275 kV transformer to be off-loaded at times when Mortlake Power Station (MOPS) was out of service, to maintain the HYTS 500 kV busbar voltage within secure limits. At the time the line outage commenced, MOPS was out of service, requiring the HYTS M2 500/275 kV transformer to be off-loaded. This meant the Heywood – Mortlake No. 2 500kV line had to be taken out of service as well.

As part of the outage, AEMO applied the V-HYMO, F-V-HYMO and F-V-APHY_ONE constraint sets in central dispatch from 0700 hours on 3 October 2011.

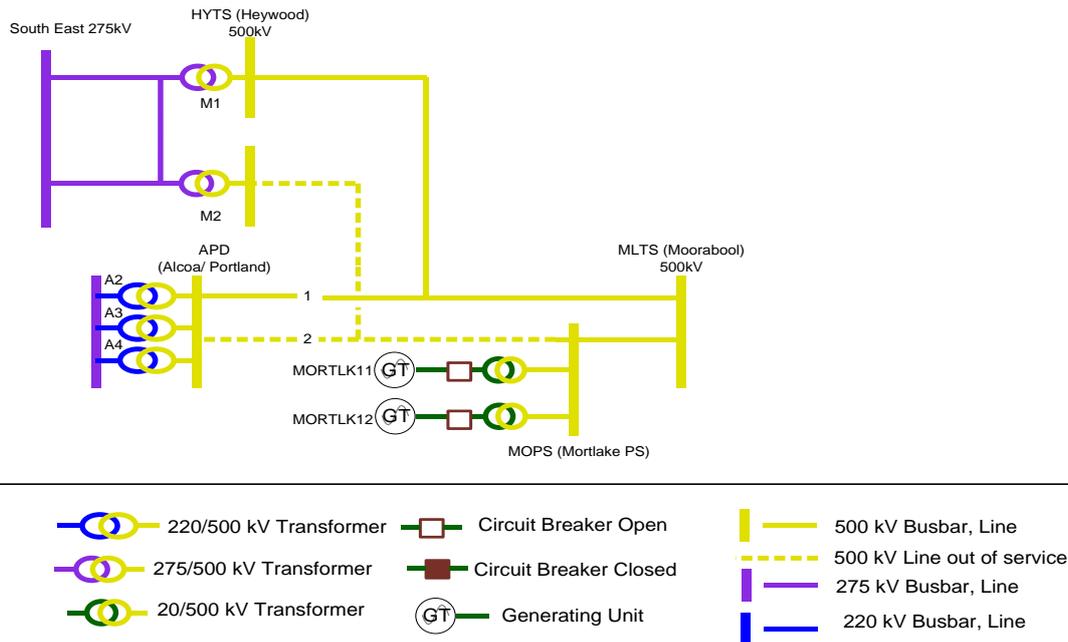
The network topology before and after the line outage is shown in Figures 1 and 2 below.

Figure 1 – Network Topology before APD – Heywood No.2 500 kV line outage



¹ Herein referred to by its Dispatchable Unit ID ‘MORTLK11’

Figure 2 – Network Topology after APD – Heywood No.2 and associated Mortlake – Heywood No.2 500 kV line outages



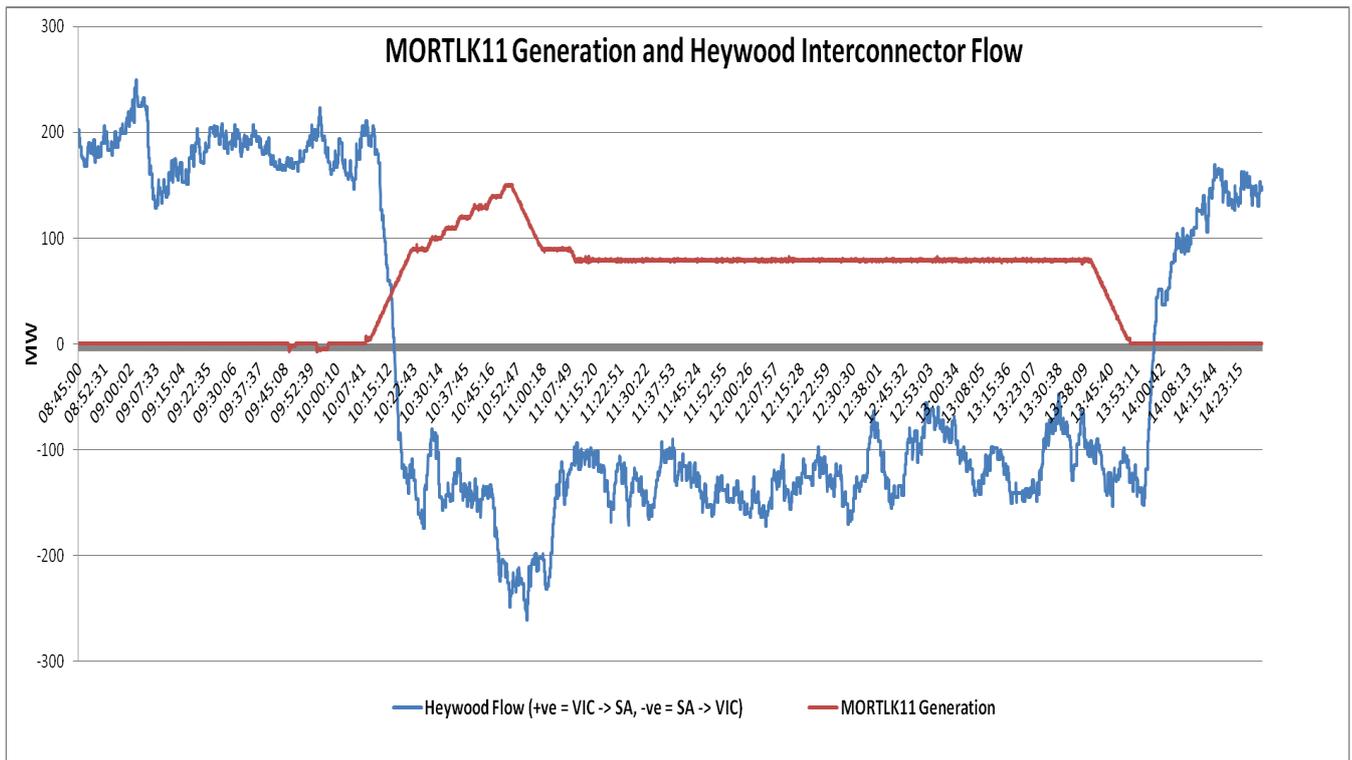
Mortlake Power Station Commissioning tests:

Commissioning tests for the MORTLK11 unit were planned for between 1000 and 1430 hours on 4 October 2011. Origin Energy had advised AEMO of its intended generation profile for MORTLK11 unit (with a maximum expected output of 180 MW) by e-mail on 3 October 2011 at 1643 hours. At 0900 hours on 4 October 2011, Origin Energy informed AEMO of its intention to delay the commissioning tests for several hours. However, at 0927 hours, Origin Energy advised AEMO that the commissioning program would proceed as originally planned.

At 1008 hours the MORTLK11 unit synchronised and increased output as part of its commissioning program. For the period the unit was generating, from dispatch interval (DI) ending 1015 hours to 1355 hours, the constraint equation V-HYMO2_1² (one equation in the V-HYMO constraint set) bound in dispatch, resulting in the reversal of the Heywood interconnector flow into Victoria. Figure 1 shows the change in direction of the flow on the Heywood interconnector and MORTLK11 unit's generation during the incident.

² For the outage of Heywood – Mortlake No.2 500 kV line, the constraint equation prevents voltage unbalance at the APD 500 kV bus, with one Mortlake unit in service.

Figure 3: Actual MORTLK11 Generation and Heywood Interconnector Flow on 4 October 2011



With the Heywood interconnector flow constrained on from South Australia into Victoria, the $F_{S++HYML_L60}^3$ constraint equation (one equation in the F-V-HYMO constraint set) violated from DI ending 1015 hours to 1110 hours. This violation was due to insufficient 60 second FCAS lower services being available in South Australia during this period. The constraint equation $F_{S++HYML_L6}^4$ also violated from DI ending 1040 hours to 1055 hours, due to insufficient 6 second FCAS lower services being available in South Australia during that period.

AEMO verified the accuracy of the violating constraint equations and were satisfied that the equations were accurate. After further analysis of the technical envelope and constraint action, AEMO determined that, in order to remove the violations and return the power system to a secure operating state, the only options were to either reduce the Heywood interconnector flow into Victoria or to reduce MORTLK11 unit's generation.

At 1051 hours AEMO was considering issuing a direction to reduce the MORTLK11 unit's output when, at 1052 hours, it received a dispatch offer from Origin Energy to voluntarily reduce output to 90 MW and hence did not proceed with the direction.

At 1245 hours AEMO informed Origin Energy that the MORTLK11 unit commissioning program had to be deferred until power system conditions were suitable.

At 1334 hours, Origin Energy informed AEMO that the MORTLK11 unit would be coming out of service, with and submitted the appropriate dispatch offer at 1336 hours. The unit ramped down and was out of service from DI ending 1400 hours.

³ Constraint equation for 60 second FCAS Lower Requirement in South Australia for the outage of one Heywood – Moorabool (HYTS – MLTS) 500 kV line or one Moorabool – Sydenham (MLTS – SYTS) 500 kV line.

⁴ Constraint equation for 6 second FCAS Lower Requirement in South Australia for the outage of one Heywood – Moorabool (HYTS – MLTS) 500 kV line or one Moorabool – Sydenham (MLTS – SYTS) 500 kV line.

3 Power System Security Assessment

There were no real time contingency analysis violations as a result of this incident.

There were no power system voltage violations or frequency deviations outside the operating standards as a result of this incident.

The extent of violation for constraint equations F_S++HYML_L60 and F_S++HYML_L6 are shown in Table 1 below.

Table 1 - Violation Degrees for F_S++HYML_L60 and F_S++HYML_L6 on 4 October 2011

Constraint Equation	Violation DI	Degree of Violation (MW)
F_S++HYML_L60	10:15	-15.92
	10:20	-22.16
	10:25	-24.59
	10:30	-0.33
	10:35	-18.64
	10:40	-24.46
	10:45	-29.21
	10:50	-30.56
	10:55	-30.16
	11:00	-3.43
	11:05	-3.89
	11:10	-15.17
F_S++HYML_L6	10:40	-4.67
	10:45	-9.79
	10:50	-9.68
	10:55	-10.12

The following issues have been identified as collectively contributing to the insecure power system incident on 4 October 2011:

Need for dispatch offers reflecting commissioning tests:

The insecure power system operation was a result of not meeting the 60 second FCAS lower service requirement in South Australia during the MORTLK11 commissioning tests. However, this issue was not flagged in pre-dispatch because Origin Energy had not submitted dispatch offers that reflected these commissioning tests sufficiently ahead of time. At 0927 hours Origin Energy informed AEMO of its intention to proceed with the commissioning tests at 1000 hours as planned, and at 1003 hours submitted dispatch offers reflecting those tests, which were used in the 1100 pre-dispatch run. Origin Energy's dispatch offers were not reflected in the 1030 pre-dispatch run because the 1030 run requires dispatch offers to be submitted by 1000 hours.

Origin Energy informed AEMO that the failure to submit dispatch offers ahead of time was primarily because Origin Energy was unsure whether the commissioning tests were going to proceed as

planned. Due to various reasons, Origin Energy had been required to cancel commissioning tests in the past and on this occasion they decided not to submit dispatch offers until it was certain the tests were going to proceed.

AEMO ran offline simulations of the 0530 and 1000 pre-dispatch runs on 4 October 2011 assuming the dispatch offers submitted for the MORTLK11 unit commissioning tests, to observe the potential outcomes for the F_S++HYML_L60 and F_S++HYML_L6 constraint equations. It was observed that in the results of both simulated runs, the pre-dispatch intervals between 1015 hours and 1110 hours (the period during which the two constraints violated in dispatch) only showed the two constraints to be binding (with high marginal values) and not violating. This is because in comparison to dispatch, pre-dispatch only runs every 30 minutes and the snapshots (inputs) taken at the 30 minute intervals may not be as accurate as the inputs that are used in dispatch. However, the results of the simulated pre-dispatch runs did show the sudden reversal of Heywood Interconnector flow and the high marginal values associated with the binding constraints. This could have given sufficient reason for AEMO not to permit the commissioning tests to proceed.

Inaccurate Network Outage Schedule (NOS) Entry:

AEMO's outage assessment procedures require TNSPs to advise of all network elements affected by an outage in their NOS submission, with grouping of all associated network elements. Origin Energy informed AEMO that it is their normal practice during the commissioning of Mortlake to check the NOS given there are several constraints that affect Mortlake. On the day of the event, the NOS published at 0839 hours had only identified a line outage for the APD – Heywood No.2 500 kV line. There was no NOS entry for the outage of the Heywood – Mortlake No.2 500 kV line as AEMO had not informed SP AusNet of the need to off-load the HYTS M2 transformer, and hence this line, whenever MOPS was out of service. This NOS misinformation led Origin Energy to believe it could proceed with the commissioning program for the MORTLK11 unit. Shortly after the incident, with MOPS no longer in service, AEMO requested SP AusNet to update the NOS entry to include the outage of Heywood – Mortlake No.2 line. This was completed at 1537 hours that day.

Operation of constraint equations:

Origin Energy submitted an offer for the MORTLK11 unit with a fixed loading reflecting its commissioning profile.

The network constraint equation V-HYMO2_1 has Mortlake Generation and Heywood (Victoria–South Australia) Interconnector terms on the left hand side. When this constraint equation bound, the National Electricity Market Dispatch Engine (NEMDE) could only satisfy this constraint by changing the flow on the Heywood Interconnector. In doing so, it violated the South Australia FCAS Lower requirements rather than constrain off Mortlake generation and violate its fixed loading constraint⁵.

If the dispatch offers had not included fixed loadings, NEMDE could have constrained off the MORTLK11 unit rather than alter the Heywood interconnector flow, although the use of fixed loadings for commissioning tests is considered appropriate.

Permission to proceed with Commissioning tests:

AEMO permitted Origin Energy to commence the commissioning tests as prior experience with constraint equations associated with the APD – HYTS No.2 500kV line outage had not indicated any system security or market issues. However, AEMO's Power System Security Guidelines⁶

⁵ Unit fixed loading constraint equations have a CVP weight of 100, whereas the 6 second and 60 second FCAS Lower requirement constraint equations have lower CVP weights of 5 and 4 respectively

⁶ Power System Security Guidelines, SO_OP 3715, can be accessed at:
<http://www.aemo.com.au/electricityops/3715.html>

requires that permission to proceed for commissioning tests only be granted if the tests are reflected in the dispatch offers submitted for that generating unit.

AEMO aims to identify power system security issues such as insufficient FCAS in the pre-dispatch timeframe so there is sufficient lead time to take remedial action.

Need for improvements to documentation on commissioning:

In preparation for the commissioning tests, AEMO highlighted to Origin Energy existing market and power system security procedures that were required to be complied with, to ensure power system security could be managed effectively. This included the need to provide dispatch offers reflecting the commissioning tests. However, a formal document explaining the specific requirements for commissioning of generating units and the issues considered by AEMO prior to and during commissioning did not exist at the time. Though this might not have directly contributed to the incident, it was identified as an important improvement in the commissioning process which could potentially assist in averting similar future incidents.

4 Follow-up Actions

The following actions were undertaken following the event:

- Origin Energy has revised its procedure for commissioning of generating units, requiring the submission of dispatch offers reflecting the expected generation profile at least one day ahead regardless of whether the commissioning schedules are firm or not, and to re-submit dispatch offers whenever changes to the expected generation profile occur.
- AEMO, SP AusNet and Origin Energy discussed ways to improve communication and co-ordination of transmission outages during the commissioning period of Mortlake.
- AEMO has published 'Commissioning Requirements for Generating Systems'⁷, a formal document explaining the specific requirements for the commissioning of generating units in Victoria and issues considered by AEMO prior to and during commissioning. This document is published as part of the Victorian Network Connections Information Kit and was made publicly available on 14 December 2011.

5 Conclusions

The combination of planned outages of the APD – Heywood No.2 and Heywood – Mortlake No.2 500 kV lines during commissioning tests on the new Mortlake Power Station Generating Unit No.1 resulted in the 60 second and 6 second Lower FCAS constraint equations violating due to insufficient FCAS services being available in South Australia. The F_S++HYML_L60 constraint equation violated between DIs ending 1015 and 1110 hours (55 minutes), resulting in an insecure power system for more than 30 minutes. AEMO restored the power system to a secure operating state by limiting Mortlake output and eventually deferring the commissioning program.

6 Recommendations

- AEMO will reinforce to its staff the need to verify potential power system security issues in pre-dispatch before issuing permission to proceed for commissioning tests of new generating units. AEMO will complete this by the end of March 2012.

⁷ The document can be accessed at:

http://www.aemo.com.au/connections/network_connections/documents/0174-0006.pdf

- AEMO to review processes for advising and communicating changes to relevant participants in relation to network re-arrangements required for transmission outages. This recommendation is already implemented.
- AEMO will consider the viability of using its simulation tools in outage assessments to identify power system security issues such as FCAS requirement shortfalls. AEMO will confirm viability and advise implementation plan by the end of June 2012.
- AEMO to develop documents detailing requirements for commissioning of generating units and issues considered by AEMO prior to and during commissioning, for generating units in states other than Victoria. This recommendation will be complete by end of July 2012.