TRIP OF THE APD-HEYWOOD-TARRONE 500 KV TRANSMISSION LINE AND APD NO.3 500 KV BUSBAR ON 7 FEBRUARY 2015

AN AEMO POWER SYSTEM OPERATING INCIDENT REPORT FOR THE NATIONAL ELECTRICTY MARKET

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

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Purpose

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VERSION RELEASE HISTORY

VERSION	DATE	BY	CHANGES	CHECKED BY	AUTHORISED BY
1	17 September 2015	R Burge	FINAL	S Darnell	J Lindley

INCIDENT CLASSIFICATIONS

Time and date and of incident	1519 hrs, Saturday 7 February 2015
Region of incident	Victoria
Affected regions	Victoria, South Australia
Event type	BB - Busbar trip
Primary cause	ENVI & LN – Environment and Lightning
Generation Impact	Nil
Customer Load Impact	Nil
Associated reports	Trip of APD-Heywood-Tarrone and Moorabool-Tarrone 500 kV transmission lines on 9 May 2014

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator
APD	Alcoa Portland
CB	Circuit Breaker
CB 5500	500 kV Circuit Breaker 5500 at APD
CBF	Circuit Breaker Fail
Heywood	Heywood Terminal Station
kV	Kilovolt
Line 1	APD – Heywood – Tarrone No.1 500 kV line
M1 Transformer	Heywood 500/275 kV M1 transformer
M2 Transformer	Heywood 500/275 kV M2 transformer
MW	Megawatt
NER	National Electricity Rules
SPAR	Single Pole Auto Reclose
Tarrone	Tarrone Terminal Station

1. INTRODUCTION

This report reviews a power system operating incident on Saturday 7 February 2015 in Victoria.

The incident involved the simultaneous trip of a 500 kV transmission line and a 500 kV busbar, and was caused by incorrect operation of a circuit breaker at Alcoa Portland (APD).

AEMO is required to assess power system security over the course of this incident as the incident is classified as a non-credible contingency under the National Electricity Rules (NER).[1] Specifically, AEMO must 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.[2]

AEMO concluded that:

- The 500 kV transmission line initially tripped for a transient fault due to lightning.
- A circuit breaker operated incorrectly causing the subsequent tripping of the 500 kV busbar.
- The issue was resolved by correcting the circuit breaker protection settings.
- The power system was not returned to a secure operating state within the required timeframe following the incident.

This report is based on information provided by AusNet Services[3] and AEMO. National Electricity Market time (Australian Eastern Standard Time) is used throughout.

2. THE INCIDENT

At 1519 hrs on Saturday 7 February 2015 the APD-Heywood-Tarrone No.1 500 kV line (Line 1) and APD No.3 500 kV busbar tripped simultaneously, offloading the Heywood 500/275 kV M1 transformer (M1 Transformer).

The busbar was restored at 1629 hrs and the line was restored at 0015 hrs on Sunday 8 February 2015. No load or generation was lost as a result of this incident.

The reason for investigating this incident is that a 500 kV busbar tripped and the power system was in a non-secure state for more than 30 minutes. The probability of a busbar fault is very low: it is an unexpected event, known in power system security terms as a 'non-credible contingency'.[4]

See Appendix 1 for a power system diagram illustrating the incident, and Appendix 2 for a chronological log of the incident.

1 Clause 4.8.15(a)(1)(i) and AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

2 NER Clause 4.8.15 (b)

3 AusNet Services is a Transmission Network Service Provider in Victoria. Information provided by AusNet Services 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 AusNet Services (or its respective associated companies, businesses, partners, directors, officers or employees).

4 NER Clause 4.2.3 - Credible and non-credible contingency events; AEMO Power System Security Guidelines, Section 10 - Definition of a non-credible contingency events

3. AUSNET INVESTIGATION

AusNet investigated this incident and found that Line 1 initially tripped on red phase only, due to a transient phase-earth fault caused by lightning. Circuit breakers at APD, Heywood and Tarrone correctly opened on single phase only.

Single Pole Auto Reclose (SPAR) should have successfully operated by reclosing the circuit breakers. However, it did not operate due to the following issues with CB 5500 at APD.

The single phase Circuit Breaker Fail (CBF) timer was correctly initiated for the Line 1 circuit breakers at APD, Heywood and Tarrone. The CBF timer delay setting on CB 5500, at the APD end, was insufficient in that it timed out almost instantaneously (before CB5500 had opened), and caused CB 5500 CBF function to operate and initiate the following:

- Opening 500 kV CB 5200 at APD on 3 phases.
- Opening 220 kV CB 2510 and CB 2530 at APD on 3 phases.
- Sending inter-trip signals to Heywood and Tarrone to open the CBs on 3 phases and preventing SPAR operation.

This resulted in the simultaneous tripping of Line 1 and APD No.3 500 kV busbar.

On Monday 9 February 2015, investigations by AusNet and Alcoa found that CB 5500 CBF timer delay was set incorrectly by AusNet staff. AusNet and Alcoa immediately corrected the CBF timer delay setting on CB 5500 ensuring the non-credible contingency will not reoccur.

4. POWER SYSTEM SECURITY

Over the course of the incident, power system security was managed by AEMO.[5]

- On Saturday 7 February 2015 at 1535 hrs (approximately 16 minutes after the incident), AEMO invoked constraint sets F-I-HYSE[6], F-V-HYTR[7], I-HYSE[8] and V-HYTR.[9] It took 16 minutes to invoke the constraints due to the time required to peer review constraint sets and equations.
- A number of constraints were violated in the dispatch intervals ending 1540, 1545 and 1550 hrs. These constraints violated due to insufficient FCAS in South Australia, limits on generator ramping and interconnector limits (see Appendix 3). The power system was returned to a secure operating state at 1550 hrs, indicating the power system was insecure for up to 31 minutes.[10]
- AEMO could not bring the power system to a secure operating state within the required 30 minutes due to the time required to invoke constraints and constraints violating for three dispatch intervals.
- At 1555 hrs (approximately 36 minutes after the incident), AEMO issued Market Notice 48088 to notify the market of a non-credible contingency event.[11]

5 AEMO is responsible for power system security in the NEM and is required to operate the power system in a secure operating state (NER Clause 4.2.4 (a)). AEMO must thereby ensure that the power system is maintained in, or returned to, a secure operating state following a contingency event.

6 Out = one Heywood to South East (HYTS-SESS) 275 kV line – FCAS requirements

7 Out = Heywood to Tarrone (HYTS-TRTS) No.1 500 kV line – FCAS requirements

8 Out = Heywood to South East 275 kV line

9 Out = Heywood to Tarrone (HYTS-TRTS) No.1 500 kV line

10 AEMO is required to return the power system to a secure state within thirty minutes following a contingency event - NER Clause 4.2.6 (b)

11 AEMO is required to notify the Market of a non-credible contingency event within two hours of the event - AEMO, Power System Security Guidelines, Section 10.3

- At 1629 hrs APD No.3 500 kV busbar was restored. CB 5500 CBF timer delay setting issue was not known and hence was not resolved at this time.
- At 1659 hrs, the Heywood-Tarrone section of Line 1 and M1 Transformer were restored. However, the APD-Heywood section of Line 1 could not be restored at this time due to a hydraulics issue with CB 5500 at Alcoa.
- AEMO disconnected Heywood 500/275 kV M2 transformer (M2 transformer) at 1717 hrs to prevent overload of the Heywood transformers while the APD-Heywood line is out of service[12]. As a result of this AEMO then invoked constraint sets V-APHY1[13] and V-HYTX[14] at 1730 hrs to ensure power system security.
- At 1730 hrs, after receiving confirmation from AusNet that the Heywood – Tarrone section of Line 1 had been restored, AEMO revoked constraint sets F-V-HYTR and V-HYTR.
- At 2330 hrs, AEMO revoked constraint sets F-I-HYSE, I-HYSE- V-APHY1 and V-HYTX after receiving confirmation from AusNet that the M2 transformer had been restored.
- On Sunday 8 February 2015 at 0015 hrs, APD-Heywood section of Line 1 was restored after resolution of the hydraulics issues with CB 5500 at Alcoa.

As required, AEMO then assessed whether the event required classification as a credible contingency.[15]

AEMO issued Market Notice 48110 at 0039 hrs on Sunday 8 February 2015, notifying the market that the incident would not be reclassified as a credible contingency. Based on the information provided to AEMO at this time, the cause of the incident was thought to be the hydraulics issue with CB 5500. Hence, AEMO did not reclassify the incident as the hydraulics issue had been resolved and the incident was unlikely to reoccur.

On Monday 9 February AusNet Services and Alcoa identified that the incident was caused by an incorrect CBF timer delay setting on CB5500. AusNet Services, in conjunction with Alcoa, reset the CBF timer on CB 5500 to the correct setting at 1200 hrs on 9 February.

5. CONCLUSIONS

AEMO concluded that:

1. The APD-Heywood-Tarrone No.1 500 kV transmission line tripped for a phase-earth fault caused by lightning.
2. APD No.3 500 kV busbar tripped after the CBF function of CB 5500 operated due to an insufficient timer delay setting.
3. CB 5500 CBF timer delay setting was corrected.
4. The power system was in an insecure operating state for 31 minutes following this incident.
5. There are no outstanding issues to resolve as a result of this incident.

12 As per procedure when temporary intertrips at Mortlake PS and APD are unavailable

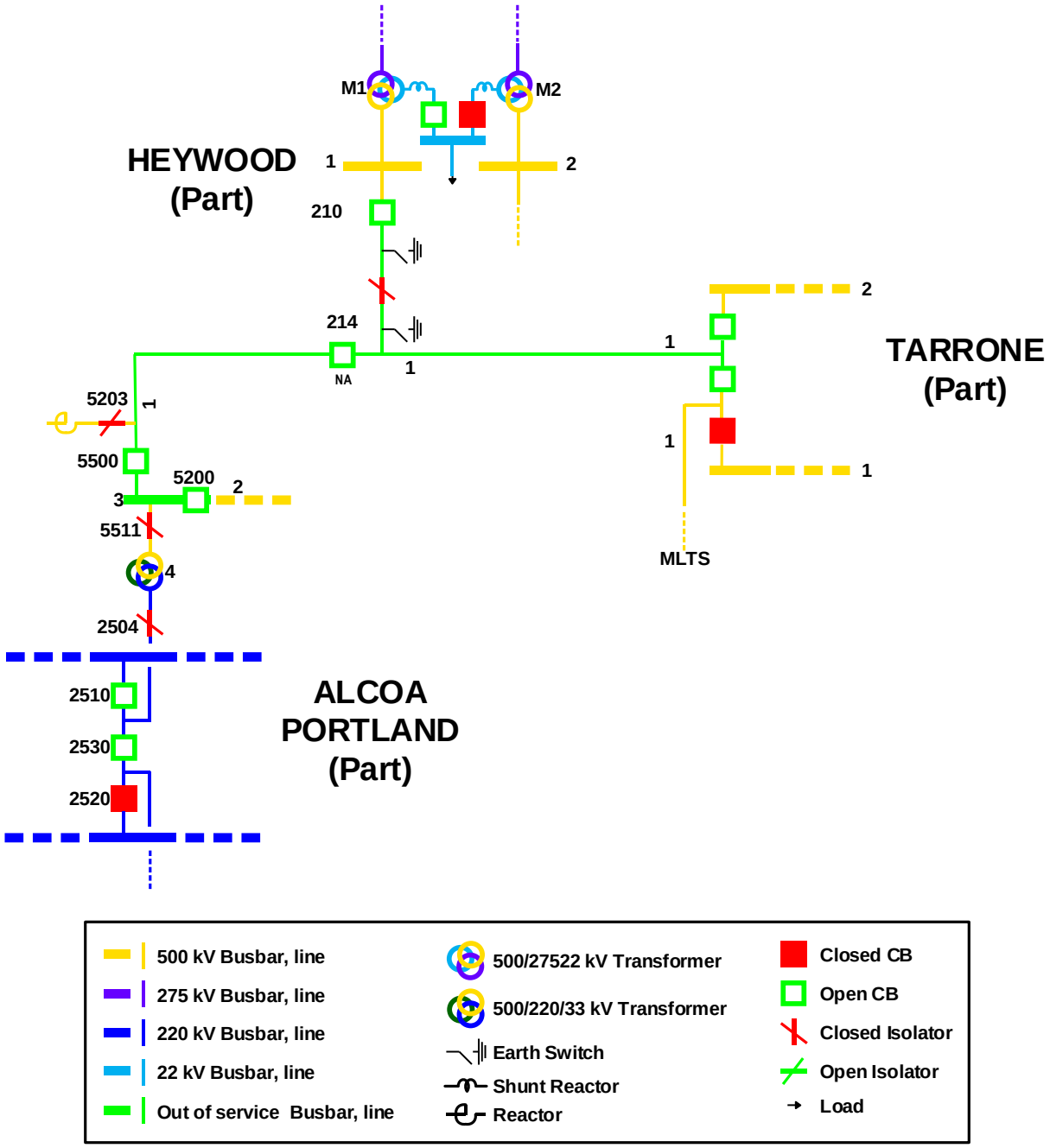
13 Out = Alcoa Portland to Heywood (APD-HYTS) No.1 500 kV line with HYTS 500/275 kV M2 transformer offloaded

14 Out = Heywood 500/275 kV (M) transformer

15 AEMO is required to assess whether or not to reclassify a non-credible contingency event as a credible contingency - NER Clause 4.2.3A (c)) - and to report how re-classification criteria were applied - NER Clause 4.8.15 (ca). AEMO has to determine if the condition that caused the non-credible contingency event has been resolved.

APPENDIX 1 – POWER SYSTEM DIAGRAM

Figure 1 The power system after the incident



APPENDIX 2 – INCIDENT EVENT LOG

Table 1 Incident Log

Time and Date	Event
1519 hrs 7 February 2015	APD – Heywood – Tarrone No.1 500 kV line and APD No.3 500 kV busbar tripped
1535 hrs 7 February 2015	AEMO invoked the following constraint sets to manage power system security: F-I-HYSE F-V-HYTR I-HYSE V-HYTR
1555 hrs 7 February 2015	AEMO issued Market Notice 48088 informing the market of the non-credible contingency
1629 hrs 7 February 2015	APD No.3 500 kV busbar returned to service
1659 hrs 7 February 2015	Heywood – Tarrone 500 kV line returned to service, Heywood M1 500/275 kV transformer loaded
1730 hrs 7 February 2015	AEMO revoked the following constraint sets: F-V-HYTR V-HYTR AEMO invoked the following constraint sets after disconnecting Heywood M2 transformer: V-APHY1 V-HYTX
2330 hrs 7 February 2015	AEMO revoked the remaining invoked constraint sets after reconnecting Heywood M2 transformer: F-I-HYSE I-HYSE V-APHY1 V-HYTX
0015 hrs 8 February 2015	APD – Heywood 500 kV line returned to service (hydraulic issue on CB 5500 at APD resolved)
0039 hrs 8 February 2015	AEMO issued Market Notice 48110 informing the market that the cause of the non-credible contingency had been identified and the event would not be reclassified as credible
1200 hrs 9 February 2015	CBF delay setting for CB 5500 was found to be incorrect and was corrected

APPENDIX 3 – VIOLATING CONSTRAINT EQUATIONS

The following constraint equations violated following the incident:

Table 2 Violating Constraints

ConstraintID	Constraint Violation Degree		
	DI ending 1540 hrs	DI ending 1545 hrs	DI ending 1550 hrs
F_S++HYML_L6	-17.1632	-34.5943	
F_S++HYSE_L6	-17.1632	-34.5943	
SV_200	50	50	
V>SML_NSWRB_9		32.7417	
V^SML_NSWRB_2	86.3065	89.0032	
V_HYML1_1	55.65	2.75	
V_HYML1_3	148.35	91.25	24.45
V_HYML1_4	76.1	19	

Table 3 Description of constraint violations

Constraint ID	Description and Explanation of violation
F_S++HYML_L6	SA Lower 6 second FCAS requirement for outage of Heywood – Moorabool 500 kV line Constraint violated for 2 DIs due to SA Lower 6 second availability less than requirement
F_S++HYSE_L6	SA Lower 6 second FCAS requirement for outage of one Heywood 500/275 kV transformer Constraint violated for 2 DIs due to SA Lower 6 second availability less than requirement
V_HYML1_1	Limit voltage unbalance at APD 500 kV busbar for outage of Heywood – Tarrone or Tarrone – Moorabool 500 kV line with one Mortlake generating unit in service Constraint violated for 2 DIs due to Mortlake unit 1 being limited by its ramp down rate
V_HYML1_3	Limit voltage unbalance at APD 500 kV busbar for outage of Heywood – Tarrone or Tarrone – Moorabool 500 kV line with one Mortlake generating unit in service Constraint violated for 3 DIs due to Mortlake unit 1 being limited by its ramp down rate
V_HYML1_4	Limit voltage unbalance at APD 500 kV busbar for outage of Heywood – Tarrone or Tarrone – Moorabool 500 kV line with one Mortlake generating unit in service Constraint violated for 2 DIs due to Mortlake unit 1 being limited by its ramp down rate
SV_200	SA to Victoria interconnector transfer limit set to maximum 200 MW Constraint violated for 2 DIs due to competing requirement of Heywood interconnector export limit set by V_HYML1_4
V^SML_NSWRB_2	Murraylink runback scheme to avoid voltage collapse for the loss of Darlington Pt – Buronga (X5) 220 kV line Constraint violated for 2 DIs due to Murraylink transfer increasing rapidly to support high SA demand while Heywood interconnector constrained
V>SML_NSWRB_9	Murraylink runback scheme to avoid overload of the Bendigo – Kerang 220 kV line for the loss of Balranald – Darlington Pt (X5/1) 220 kV line Constraint violated for 1 DI due to Murraylink transfer increasing rapidly to support high SA demand while Heywood interconnector constrained