TRIP OF LOY YANG POWER STATION No.1 AND No.3 500 KV BUSBARS ON 31 MAY 2017

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

Published: **30 August 2017**

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1116 hrs Wednesday 31 May 2017
Region of incident	Victoria
Affected regions	Victoria
Event type	Busbar trip (BB)
Generation Impact	1010 MW was disconnected as a result of this incident
Customer Load Impact	No customer load was disconnected as a result of this incident
Associated reports	Trip of No1 & No3 500kV busbars at Loy Yang on 16 June 2016

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator
AGL	AGL Energy – Operator of LYPSA
AusNet	AusNet Services – Operator of LYPS Switchyard
CB	Circuit Breaker
CBF	Circuit Breaker Fail
FCAS	Frequency Control Ancillary Service
kV	Kilovolt
LYPS-A	Loy Yang Power Station A
LYPS	Loy Yang Power Station Switchyard
MW	Megawatt
NER	National Electricity Rules
NOFB	Normal Operating Frequency Band
VPGS	Valley Power Gas Station

IMPORTANT NOTICE

Purpose

AEMO has prepared this report in accordance with clause 4.8.15(c) of the National Electricity Rules, using information available as at the date of publication, unless otherwise specified.

Disclaimer

AEMO has made every effort to ensure the quality of the information in this report but cannot guarantee its accuracy or completeness. Any views expressed in this report are those of AEMO unless otherwise stated, and may be based on information given to AEMO by other persons.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this report:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this report; and
- are not liable (whether by reason of negligence or otherwise) for any statements or representations in this report, or any omissions from it, or for any use or reliance on the information in it.

Copyright

© 2017. Australian Energy Market Operator Limited. The material in this publication may be used in accordance with the copyright permissions on AEMO's website.

CONTENTS

1. OVERVIEW 4

2. THE INCIDENT 4

3. AUSNET SERVICES INVESTIGATION 5

4. AGL ENERGY INVESTIGATION 5

5. POWER SYSTEM SECURITY 6

5.1 Frequency 6

5.2 Reclassification 7

6. MARKET INFORMATION 7

7. CONCLUSIONS 7

APPENDIX A. POWER SYSTEM DIAGRAM 9

APPENDIX B. INCIDENT EVENT LOG 10

© AEMO 2017

1. OVERVIEW

This report reviews a power system operating incident[1] that occurred on 31 May 2017 at Loy Yang Power Station Switchyard (LYPS) in Victoria. This incident involved the trip of LYPS No.1 and No.3 500 kV busbars, and generating units 1 and 3 at Loy Yang Power Station A (LYPS-A). The incident was caused by a circuit breaker (CB) not opening correctly.

There was no loss of customer load as a result of this incident.

As this was a reviewable operating incident, AEMO is required to assess power system security over the course of this incident, specifically 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 has concluded that:

1. The incident was caused by a faulty CB.
2. The subsequent trip of associated plant was as expected for this CB fault.
3. AusNet has replaced the hydraulic operating mechanism of the faulty CB.
4. The provision and response of facilities and services were appropriate over the course of this incident.

This report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It is based on information provided by AusNet Services (AusNet)[3], AGL Energy (AGL)[4], and AEMO. Australian Eastern Standard Time is used in this report.

2. THE INCIDENT

On Wednesday 31 May 2017 at 1116 hrs, LYPS-A generating unit 3 was tripped from 450 MW as part of a planned trip test. The test required the opening of the two generator 500 kV CBs in LYPS. However, one of the CBs – the A3 Generator 1 Bus 500kV CB – failed to open correctly. As a result:

- LYPS No.1 and No.3 500 kV busbars (No.1 and 3 busbars) tripped.
- LYPS-A generating unit 1 was islanded and subsequently tripped.
- Hazelwood – Loy Yang No.2 500 kV line (HWTS–LYPS No.2 line) was off-loaded.
- Loy Yang – Valley Power 500 kV Line (LYPS–VPGS line) was disconnected.[5]

There was no loss of customer load, however there was an unplanned loss of 560 MW of generation.[6]

See Appendix A for a power system diagram illustrating the incident and Appendix B for a chronological log of the incident.

The minimum frequency during this event was 49.59 Hz in the mainland and 48.54 Hz in Tasmania. The frequency in the mainland recovered to the Normal Operating Frequency Band (NOFB) within six minutes and in Tasmania within seven minutes. The frequency operating standards were met for this incident.

No.1 and No.3 busbars, HWTS-LYPS No.2 line and the LYPS-VPGS line were returned to service at 1202 hrs on 31 May 2017. LYPS-A generating unit 1 was returned to service at 1220 hrs, and LYPS-A generating unit 3 was returned to service at 1446 hrs.

[1] See NER clause 4.8.15(a)(1)(i), as the event relates to a non-credible contingency event; and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.
[2] See NER clause 4.8.15(b).
[3] 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] AGL Energy is the operator of LYPSA.
[5] Valley Power was not generating at the time of the event.
[6] 1010 MW of generation was lost in total: 450 MW was planned (trip of LYA3) and 560 MW was unplanned (trip of LYA1)

© AEMO 2017

On 16 June 2016, a similar event occurred at Loy Yang during planned testing. A report on this event is available on the AEMO website[7].

The reason for reviewing this incident is that a busbar tripped. A busbar trip is a non-credible contingency event[8], which means the event is a reviewable operating incident under the National Electricity Rules (NER).

3. AUSNET SERVICES INVESTIGATION

The following is based on information provided by AusNet Services, as operator of LYPS.

At 1116 hrs on 31 May 2017, LYPS No.1 and No.3 500kV busbars tripped via protection.

A trip signal was initiated from the LYPS A generating unit 3 as part of the planned trip test. Information obtained from the relevant protection relay of the A3 Gen Trans No1 Bus 500 kV CB indicated that after receipt the trip signal, the A3 Gen Trans No1 Bus 500 kV CB "R" phase opened within 30 ms; "B" phase opened in 227.75 ms and "W" phase opened in 596.31 ms. Correct CB operation would be expected to have all three phases opened in the order of 40 ms of receipt of the trip signal.

A CB Fail trip was initiated when the CB Fail timer expired 100 ms after receipt of the initial trip signal as the A3 Gen Trans No1 Bus 500 kV CB had not correctly opened by this time. All CBs connected to the No1-No3 500 kV busbar were tripped by the CB Fail protection within 80 ms of initiation of the CB Fail trip. Operation of the CB Fail protection was a correct outcome for this type of fault, and the CB Fail protection operated correctly to trip the No1-No3 500 kV busbar.

The A3 Generator No.1 bus 500 kV CB was isolated pending further investigation. The No1 and No3 500 kV busbars were returned to service at 1202 hrs on 31 May.

Since the 16th June 2016 incident when the A3 Generator No.1 bus 500 kV CB had failed to open correctly, the CB had operated correctly on three occasions earlier in May 2017.

Following the incident on 31 May 2017, timing tests were carried out on each of the three CB operating mechanisms using both "X" and "Y" trip coils. The CB operation and timing tests were found to be satisfactory. As the root cause of the slow operation of the A3 Gen 1B 500 kV CB was not found, AusNet replaced the hydraulic operating mechanism on all three phases of the CB. On completion of this work and satisfactory testing, the CB was returned to service on 13 July 2017.

4. AGL ENERGY INVESTIGATION

The following is based on information provided by AGL, as operator of LYPS-A.

On Wednesday 31 May at 1116 hrs, AGL initiated a trip of LYPS-A generating unit 3 as part of a planned test. The unit was generating 450 MW at the time of the trip, and this loss of generation was expected.

Data from AGL's control system shows that the A3 Gen Trans Bus 2 500kV CB opened within 14 ms while the A3 Gen Trans Bus 1 500 kV CB opened after 610 ms. The delay caused the backup protection to clear the No. 1 & 3 500 kV bus, resulting in the loss of connection for LYPS-A generating unit 1. This resulted in the LYPS-A generating unit 1 tripping to house load. The generating unit remained energised and at synchronous speed until it was re-synchronised to the No.1 busbar at 1220 hrs on 31 May.

Unit 3 was returned to service at 1446 hrs on 31 May.

[7] Available at: http://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2016/Trip-of-Loy-Yang-500-kV-busbar-and-Loy-Yang-A-Units-1-and-3.pdf

[8] NER Clause 4.2.3 - Credible and non-credible contingency events; *AEMO Power System Security Guidelines,* Section 10 - Definition of a non-credible contingency event, available at https:/www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation.

© AEMO 2017

5. POWER SYSTEM SECURITY

AEMO is responsible for power system security in the NEM. This means AEMO is required to operate the power system in a secure operating state and return the power system to a secure state following a contingency event. This section assesses how AEMO managed power system security over the course of this incident.[9]

Following the event, AEMO invoked constraint sets V-HWLY_2[10], V-LY_BUS1[11] and V-LY_BUS3[12] within nine minutes. These actions ensured that the power system was restored to, and maintained in, a secure operating state. No further actions were required to maintain power system security.

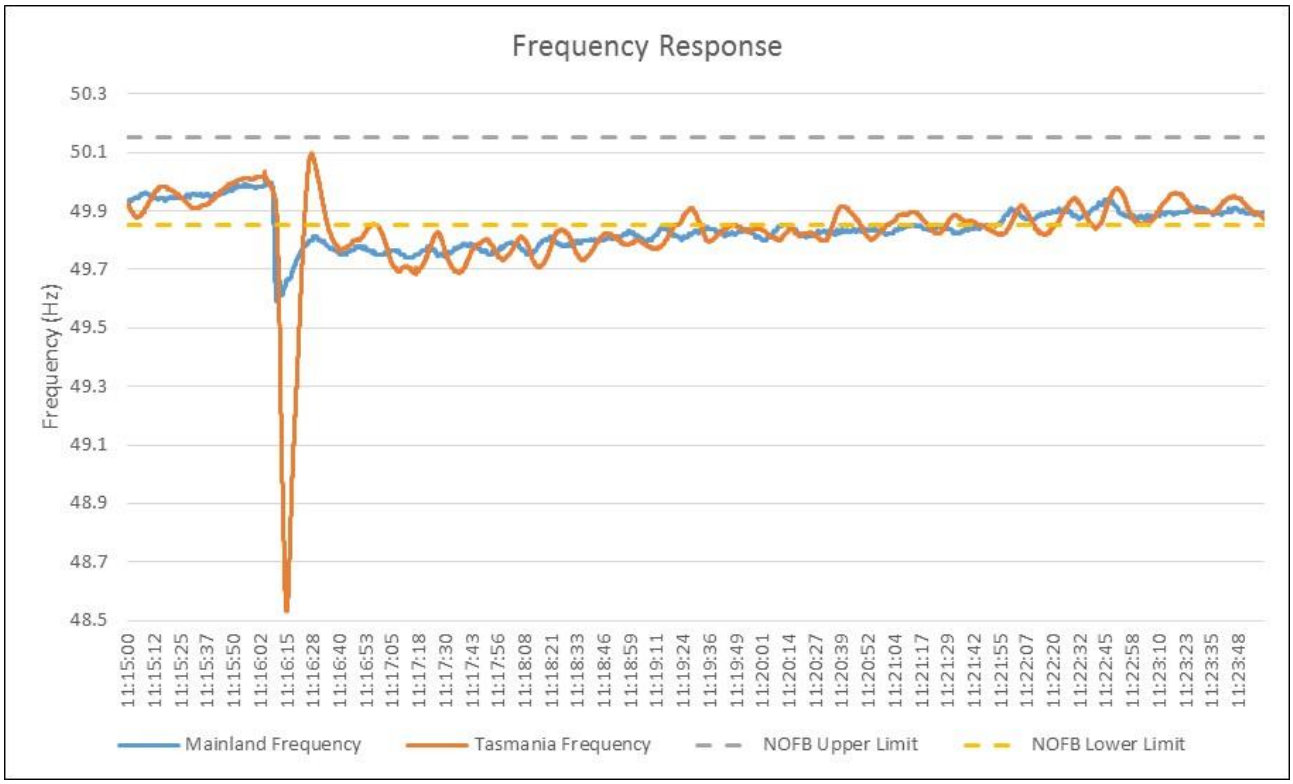
5.1 Frequency

The minimum frequency during this event was 49.59 Hz in the mainland and 48.54 Hz in Tasmania. As this was a multiple contingency event[13], the following frequency standards apply:

- Mainland: frequency must not fall below 47 Hz, and must recover to above 49.5 Hz within two minutes and 49.85 Hz within 10 minutes.[14]
- Tasmania: frequency must not fall below 47 Hz, and must recover to above 48 Hz within two minutes and 49.85 Hz within 10 minutes.[15]

The frequency on the mainland recovered to the Normal Operating Frequency Band (NOFB) within six minutes and in Tasmania within seven minutes. For this incident, the frequency operating standards were met in both the mainland and Tasmania. Figure 1 illustrates the mainland and Tasmania frequency responses during the incident.

Figure 1 Mainland and Tasmania frequency



[9] AEMO is responsible for power system security in the NEM and is required to operate the 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.
[10] Outage of Hazelwood to Loy Yang No.2 500 kV Line.
[11] Outage of Loy Yang PS No 1 500 kV Bus.
[12] Outage of Loy Yang PS No 3 500 kV Bus.
[13] As defined in the Frequency Operating Standards
[14] See the AEMC Reliability Panel Frequency Operating Standards (Mainland).
[15] See the AEMC Reliability Panel Frequency Operating Standards (Tasmania).

© AEMO 2017

5.2 Reclassification

After the 500 kV busbars had been returned to service, AEMO, in accordance with clause 4.2.3A of the NER, assessed whether or not to reclassify the event as a credible contingency event.[16] As the cause of the contingency was identified and the faulty CB isolated, AEMO was satisfied that the non-credible contingency event was unlikely to reoccur, and did not reclassify it as a credible contingency event.

For this incident, AEMO took appropriate action to ensure the power system was returned to, and maintained in, a secure operating state.

6. MARKET INFORMATION

AEMO is required by the NER and operating procedures to inform the market about incidents as they progress. This section assesses how AEMO informed the market[17] over the course of this incident.

For this incident, AEMO was required to inform the market on the following matters:

1. The occurrence of a non-credible contingency event - notify within two hours of the event.[18]
   - AEMO issued Market Notice 58657 at 1153 hrs – 37 minutes after the event.
2. Updates to the non-credible contingency event – as information becomes available.[19]
   - AEMO issued Market Notice 58658 at 1221 hrs – 65 minutes after the event, to notify that AEMO had been advised there had been 33 MW of disconnection of bulk electrical load in the Tasmania region[20].
   - AEMO issued Market Notice 58659 at 1229 hrs – 73 minutes after the event, to notify that No.1 and 3 busbars had been returned to service and the event would not be reclassified as a credible contingency event.
3. Constraints invoked with interconnector terms on the LHS.[21]
   - AEMO did not publish a market notice when constraint set V-HWLY_2 was invoked, which contains equations with interconnector terms on the LHS. The constraint equation in this set did not bind in the time it was invoked.

AEMO has reiterated the importance of following standard procedures to operational staff and this will be specifically covered in upcoming skills maintenance and simulator training.

7. CONCLUSIONS

AEMO assessed this incident in accordance with clause 4.8.15(b) of the NER. In particular, AEMO has assessed the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.

AEMO has concluded that:

1. The incident was caused by a faulty CB.
2. The subsequent trip of associated plant was as expected for this CB fault.
3. AusNet has replaced the hydraulic operating mechanism of the faulty CB.

[16] 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.
[17] AEMO generally informs the market about operating incidents as they progress by issuing Market Notices – see AEMO website at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events.
[18] 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.
[19] AEMO is required to notify the Market as it becomes aware of new and material information – NER Clause 4.2.3A(d).
[20] The load lost in Tasmania has been identified as having been load that disconnected due to the disturbance, not as a result of disconnection from the power system nor load shedding.
[21] For short term outage AEMO is required to notify the Market of variances to interconnector transfer limits AEMO, *Power System Security Guidelines,* Section 22.

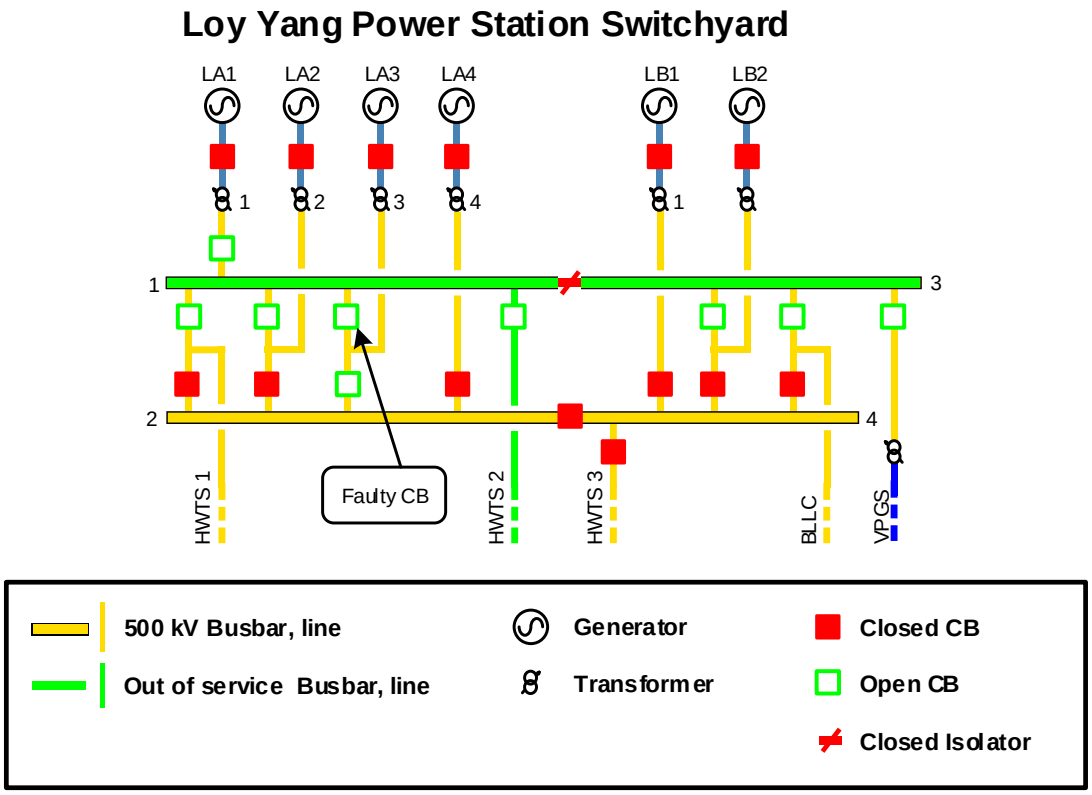
© AEMO 2017

4. The provision and response of facilities and services were appropriate over the course of this incident.

© AEMO 2017

APPENDIX A. POWER SYSTEM DIAGRAM

The power system at Loy Yang Power Station Switchyard immediately after the incident.



APPENDIX B. INCIDENT EVENT LOG

Chronological Log of Incident

Time and Date	Event
1116 hrs Wed 31 May 2017	Planned trip of LYPS-A3
1116 hrs	Tripped: • LYPS No.1 and 3 500 kV busbars, • LYPS-A 1 and LYPS-A 3 generating units Off-loaded: • Hazelwood to Loy Yang No.2 500 kV line. Disconnected: • Loy Yang – Valley Power 500 kV line.
1122 hrs	Mainland system frequency recovered to within the NOFB
1123 hrs	Tasmania frequency recovered to within the NOFB
1125 hrs	Constraint sets invoked: • V-HWLY_2 • V-LY_BUS1 • V-LY_BUS3.
1153 hrs	Market Notice 58657 issued.
1202 hrs	Returned to service: • LYPS No.1 and No.3 500 kV busbars • Hazelwood to Loy Yang No.2 500 kV line returned to service • Loy Yang – Valley Power 500 kV line returned to service.
1220 hrs	Returned to service: • LYPS-A 1 generating unit
1221 hrs	Market Notice 58658 issued.
1225 hrs	Constraint sets revoked: • V-HWLY_2 • V-LY_BUS1 • V-LY_BUS3
1229 hrs	Market Notice 58659 issued.
1446 hrs	Returned to service: • LYPS-A 3 generating unit
0915 hrs 13 Jul 2017	Returned to service: • Failed CB (LYPS-A 3 No.1 bus 500 kV CB).

© AEMO 2017