AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Trip of the Sydenham–Moorabool No. 2 500 kV line and the Sydenham–Keilor 500 kV line on 18 February 2019

October 2019

Reviewable Operating Incident Report under the National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1956 hrs on 18 February 2019
Region of incident	Victoria
Affected regions	Victoria
Event type	Transmission line fault and protection mal-operation
Generation impact	No generating unit was disconnected or had its output limited as a result of this incident
Customer load impact	No customer load was disconnected as a result of this incident
Associated reports	Nil

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator Ltd
AEST	Australian Eastern Standard Time
AusNet	AusNet Services Pty Ltd
HV	High voltage
KTS	Keilor Terminal Station
kV	Kilovolt
MLTS	Moorabool Terminal Station
ms	Millisecond
NEM	National Electricity Market
NER	National Electricity Rules
SYTS	Sydenham Terminal 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 reasonable effort to ensure the quality of the information in this report but cannot guarantee its accuracy or completeness. Any views expressed in this report may be based on information given to AEMO by other persons.

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1. Overview

This report relates to a reviewable operating incident[1] that occurred on 18 February 2019 in Victoria. The incident involved the simultaneous trip of the Sydenham–Moorabool No. 2 500 kV (SYTS-MLTS 2) line and the Sydenham–Keilor 500 kV (SYTS-KTS) line.

No generation or customer load was lost as a result of this incident.

As this was a reviewable operating incident, AEMO is required 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[2].

AEMO has concluded that:

1. The trip of the SYTS-MLTS 2 line was due to a high voltage (HV) fault on the line, and all protection equipment operated as designed and as expected to clear the fault. The cause of the fault has not been conclusively determined.
2. The trip of the SYTS-KTS line was due to the operation of a redundant element of the protection system that should not have been in service. There was no HV fault on the SYTS-KTS line.
3. AusNet Services (AusNet) has confirmed that the redundant protection element has been disabled, this protection error was unique to the SYTS-KTS line, and does not occur elsewhere in the Victorian transmission system. .
4. The auto-reclose on the SYTS-MLTS 2 line at MLTS did not operate due to a logic error in the auto-reclose system. AusNet has advised AEMO that it has implemented changes to correct the logic error.
5. Based on information provided by AusNet Services (AusNet) at the time of the incident, AEMO determined that reclassification of the simultaneous loss of the SYTS-MLTS 2 line and the SYTS-KTS line as a credible contingency event was not required.
6. Based on learnings from this Incident, AEMO has reviewed its process for reclassifications during incidents where there are unexpected protection operations.
7. The power system remained in a secure operating state throughout 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] and AEMO.

National Electricity Market time (Australian Eastern Standard Time [AEST]) is used in this report. At the time of this incident, local time in Victoria was AEST plus one hour.

[1] See NER clause 4.8.15(a)(1)(i) and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents. The incident was classified as a non-credible contingency event (see NER 4.2.3(e));

[2] See NER clause 4.8.15(b).

[3] AusNet Services is the transmission network service provider (TNSP) in the Victoria region. "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)."

2. The incident

2.1 The incident

At 1956 hrs on 18 February 2019, the SYTS-MLTS 2 and SYTS-KTS lines tripped simultaneously. As there are no line circuit breakers on the SYTS-KTS line at SYTS this also resulted in the outage of the No2 500kV busbar at SYTS. Refer to Appendix A1 for a diagram showing the relevant part of the power system immediately after the incident.

The SYTS-MLTS 2 line successfully auto-reclosed at SYTS two seconds later. The auto-reclose on this line at the MLTS end was un-successful. The auto-reclose on the SYTS-KTS line did not operate.

At 2016 hrs on 18 February 2019, AusNet de-energised the SYTS-MLTS 2 line pending further investigation.

The No. 2 500 kV busbar at SYTS and the SYTS-KTS line were returned to service at 2340 hrs on 18 February 2019.

The SYTS-MLTS 2 line was returned to service at 1241 hrs on 19 February 2019.

2.2 AusNet investigation

The following is based on information provided by AusNet.

2.2.1 Trip SYTS-MLTS line

At 1956 hrs on 18 January 2019, the SYTS-MLTS 2 line tripped due to a high voltage (HV) phase[4] to earth fault on the line, with both the 'X' and 'Y' protection relays operating. The fault was cleared within 70 ms[5] and all protection operated as designed and as expected. Fault location recorders indicated a fault very close to the MLTS end of the line.

The SYTS-MLTS 2 line successfully auto-reclosed at the SYTS end, but the auto-reclose did not operate at the MLTS end due to incorrect auto-reclose logic at MLTS. This left the line energised from SYTS but not loaded.

Due to the unknown nature of the fault, AusNet de-energised the line at 2016 hrs on 18 February 2019 to allow further investigation. Inspection of the switchyard equipment at MLTS revealed a flashover on the white phase between the corona ring and arcing rod at the line landing structure. This correlates with the operation of the protection relays and the predicted fault location. There was also evidence of bird droppings on the insulators and yoke plate, suggesting the fault may have been caused by a bird streamer[6]. A patrol of the line found no other indications of a fault, and Ausnet was not able to conclusively determine the cause of the fault.

The SYTS-MLTS 2 line was returned to service at 1241 hrs on 19 February 2019.

AusNet has confirmed that it has implemented changes to the auto-reclose logic at MLTS to ensure correct operation.

2.2.2 Trip of SYTS-KTS line

Coincident with the trip of the SYTS-MLTS 2 line, the SYTS-KTS line also tripped. This was not an expected outcome for the fault on the SYTS-MLTS 2 line. Initial investigations and a line patrol confirmed there was no

[4] White phase.

[5] This meets the requirements of NER clause S5.1a.8.

[6] Large birds are known to sit on electricity towers. When they take flight they often empty their bowels. These streams are known as streamers.

HV fault on the SYTS-KTS line, and the line and the No. 2 500 kV busbar at SYTS were returned to service at 2340 hrs on 18 February 2019.

Analysis of protection relays by AusNet during normal business hours indicated the SYTS-KTS line tripped due to instantaneous operation of the 'X' protection Back-up Overcurrent relay in response to the fault on the SYTS-MLTS 2 line. There was no operation of the 'Y' protection system. AusNet advised AEMO that Back-up Overcurrent protection is not enabled as part of protection systems in the AusNet network, but it had been inadvertently enabled as part of the 'X' protection system on the SYTS-KTS line at both SYTS and KTS. The 'X' protection system was modified to disable the Back-up Overcurrent function prior to the SYTS-MLTS 2 being returned to service at 1241 hrs on 19 February 2019.

AusNet has reviewed other similar protection systems within their transmission network in Victoria and has determined there are no other cases where the Back-up Overcurrent protection has been enabled. AusNet was not able to determine the reason for the inadvertent enablement on the SYTS-KTS line.

According to AusNet, a feature of the Back-up Overcurrent protection is that it will automatically block the auto-reclose function. As such, the auto-reclose on the SYTS-KTS line did not operate during this incident.

3. Power system security

AEMO is responsible for power system security in the National Electricity Market (NEM). This means AEMO is required to operate the power system in a secure operating state to the extent practicable and take all reasonable actions to return the power system to a secure state following a contingency event in accordance with the NER[7].

Prior to the Incident, the power system was in a secure operating state. In response to the incident, AEMO invoked constraint sets V-KTSY_R[8] and V-MLSY_NOEMTT_R[9] at 2010 hrs on 18 February 2019 to ensure that the power system would return to and remain in a secure operating state.

None of the constraint equations in the above constraint sets bound[10] during this incident, and therefore they had no impact on market outcomes.

AEMO was not required to take any other actions to restore the power system to a secure operating state following this incident.

3.1 Reclassification

AEMO assessed whether or not to reclassify this incident as a credible contingency event[11].

Prior to giving AusNet permission to restore the SYTS-KTS line to service, AEMO sought information from AusNet about how this line tripped. AusNet advised AEMO it believed the trip of the SYTS-KTS line was due to operation of over current protection in response to the fault on the SYTS-MLTS 2 and associated high fault current. Based on this advice from AusNet, AEMO agreed the SYTS-KTS line could be returned to service and that reclassification of the simultaneous loss of the SYTS-KTS line and other lines in the area as a credible contingency event was not required.

[7] Refer to AEMO's functions in section 49 of the National Electricity Law and the power system security principles in clause 4.2.6 of the NER.

[8] Out= Keilor to Sydenham 500kV line. Radial mode.

[9] Out = One Moorabool to Sydenham 500kV line, EMTT scheme not armed, radial ode.

[10] A constraint is considered as binding if it changes the optimal market solution. Non binding constraints have no impact on the market solution.

[11] AEMO is required to assess whether or not to reclassify a non-credible contingency event as a credible contingency event – NER clause 4.2.3A(c) – and to report how the reclassification criteria were applied – NER clause 4.8.15(ca).

Although AEMO did query the unexpected trip of the SYTS-KTS line with AusNET, AEMO did not ask the specific question as to whether a further trip of the SYTS-KTS line was likely for a fault on other 500 kV lines in the area[12], which may then have led to a reclassification of the simultaneous trip of the SYTS-KTS line and any other 500 kV lines in the area as a credible contingency.

As the Back-up Overcurrent function on the SYTS-KTS line was disabled shortly after the problem was identified and before the SYTS-MLTS 2 line was returned to service, AEMO correctly determined that reclassification of the simultaneous loss of the SYTS-MLTS 2 line and the SYTS-KTS line was not required.

AEMO updated relevant operating procedures and training programs associated with reclassification due to unexpected protection system operations. The updates aim to ensure that advice from the relevant TNSP or generators is sought regarding the likelihood of multiple transmission line or generating unit disconnection arising from the impact of protection or control systems malfunction. Based on this advice AEMO will initiate a reclassification of a non-credible contingency event to a credible contingency event.

4. Market informationIn

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[13] over the course of this incident.

For this incident, AEMO informed the market on the following matters:

1. A non-credible contingency event – notify within two hours of the event[14].
   - AEMO issued Market Notice 67314 at 2041 hrs on 18 February 2019, 45 minutes after the event, to advise of the non-credible contingency event.
2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical[15].
   - AEMO issued Market Notice 67321 at 1241 hrs on 19 February 2019 to advise that the SYTS-MLTS line had been returned to service and that would not reclassify the incident as a credible contingency.
3. Constraints invoked with interconnector terms on left hand side[16].
   - AEMO issued Market Notice 67313 at 2020 hrs on 18 February 2019 to advise it had invoked constraint sets V-KTSY_R and V-MLSY_NOEMTT_R. These constraint sets contain constraint equations with interconnector terms on the LHS.

[12] For example the SYTS-MLTS 1 line.

[13] AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see https://www.aemo.com.au/Market-Notices.

[14] 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, available at SO_OP3715 Power System Security Guidelines.

[15] AEMO is required to notify the market of a reclassification – NER clause 4.2.3(g), details of the reclassification – 4.2.3(c), and when AEMO cancels the reclassification – 4.2.3(h).

[16] For short notice outages, AEMO is required to notify the Market of variances to interconnector transfer limits as per section 22 of AEMO's Power System Security Guidelines.

5. Conclusions

AEMO has 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 trip of the SYTS-MLTS 2 line was due to a high voltage (HV) fault on the line, and all protection equipment operated as designed and as expected to clear the fault. The cause of the fault has not been conclusively determined.
2. The trip of the SYTS-KTS line was due to the operation of a redundant element of the protection system that should not have been in service. There was no HV fault on the SYTS-KTS line.
3. AusNet Services (AusNet) has confirmed that the redundant protection element has been disabled, this protection error was unique to the SYTS-KTS line, and does not occur elsewhere in the Victorian transmission system. .
4. The auto-reclose on the SYTS-MLTS 2 line at MLTS did not operate due to a logic error in the auto-reclose system. AusNet has advised AEMO that it has implemented changes to correct the logic error.
5. Based on information provided by AusNet Services (AusNet) at the time of the incident, AEMO determined that reclassification of the simultaneous loss of the SYTS-MLTS 2 line and the SYTS-KTS line as a credible contingency event was not required.
6. Based on learnings from this Incident, AEMO has reviewed its process for reclassifications during incidents where there are unexpected protection operations.
7. The power system remained in a secure operating state throughout this incident.

A1. System diagram

The diagram below provides an overview of part of the power system immediately after the incident.