



OFFLOADING OF ROTS– SMTS–KTS 500 KV LINES ON 1 SEPTEMBER 2017

REVIEWABLE OPERATING INCIDENT REPORT UNDER THE
NATIONAL ELECTRICITY RULES

Published: **November 2017**





INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1237 hrs Wednesday 1 September 2017
Region of incident	Victoria
Affected regions	Victoria
Event type	Procedural error
Generation Impact	No generator was disconnected or 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
CB	circuit breaker
DC	direct current
KTS	Keilor Terminal Station
kV	Kilovolt
MW	Megawatt
NER	National Electricity Rules
ROTS	Rowville Terminal Station
SMTS	South Morang Terminal Station
CBTS	Cranbourne 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

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1. OVERVIEW

This report relates to a reviewable operating incident¹ that occurred on 1 September 2017 at South Morang Terminal Station (SMTS) in Victoria. This incident involved the offloading of the Rowville Terminal Station (ROTS) to SMTS No3 500 kV line, and the SMTS to Keilor Terminal Station (KTS) 500 kV line. During this incident, the ROTS-SMTS-KTS lines remained energised from the KTS end only.

The incident was caused by inadequate secondary system isolation during protection testing when a faulty protection relay was being replaced and recommissioned.

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

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

- This incident occurred due to inadequate isolation during testing of protection equipment when a faulty relay was being replaced and recommissioned.
- The procedures relating to the protection isolation requirements during the initial fault investigation and the follow-up repair/rectification work have been reiterated to all AusNet Services (AusNet)³ field staff.
- The power system remained in a secure operating state over the course of the 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 AusNet⁴ and from AEMO Energy Management Systems.

National Electricity Market time (Australian Eastern Standard Time) is used in this report.

2. THE INCIDENT

At 1237 hrs on Wednesday 1 September 2017, protection operated to offload the SMTS–KTS 500 kV line and the SMTS–ROTS No3 500 kV line. The following circuit breakers (CBs) opened:

- CB in SMTS between SMTS No1 500kV busbar and SMTS–KTS 500 kV line.
- CB in SMTS between SMTS No2 500kV busbar and SMTS–ROTS No3 500 kV line.
- CB in ROTS between ROTS No1 500kV busbar and ROTS -SMTS No3 500 kV line.
- Coupler CB in ROTS between ROTS -SMTS No3 500 kV line and Cranbourne to Rowville No4 500 kV line.

During this incident, the ROTS-SMTS-KTS 500kV lines remained energised from KTS end only. No load or generation was lost as a result of this incident. Both SMTS-ROTS No3 500kV line and SMTS-KTS 500kV line were returned to service by 1307 hrs on 1 September. Appendix A indicates the relevant section of the power system diagram illustrating the incident.

The reason for investigating this incident is that the simultaneous offloading of the SMTS–KTS 500 kV line and the SMTS–ROTS No3 500 kV line is an unexpected event and is identified in power system security terms as a non-credible contingency.⁵

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, available at <http://www.aemc.gov.au/getattachment/134a66d6-de01-40b7-acdf-1e6d537f0975/System-Operating-Incidents-Guidelines.aspx>.

² See NER clause 4.8.15(b).

³ AusNet is the Transmission Network Service Provider (TNSP) in the Victorian region.

⁴ 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).

⁵ NER Clause 4.2.3, Credible and non-credible contingency events; and AEMO, *Power System Security Guidelines* (SO_OP 3715), 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>.

3. AUSNET INVESTIGATION

The following is based on information provided by AusNet, as asset owner and operator of the transmission network in Victoria.

3.1 Pre-incident events

At 0256 hrs on 1 September 2017, the SMTS–KTS 500 kV line ‘Y’ current differential protection relay at SMTS was proven to be faulty after investigation of alarms received earlier in the morning.

At 0617 hrs on 1 September, AusNet isolated the faulty relay by removing the SMTS–KTS 500kV line ‘Y’ protection trip links at SMTS and KTS. The SMTS–KTS 500 kV line remained in service on ‘X’ protection only.⁶

After the faulty relay was replaced, preparations were made to test the relay, including shorting out of the current inputs to the relay at SMTS to allow for current injection tests.

3.2 Incident

Since the SMTS–KTS 500 kV line remained in service and on-load, the shorting out of the current inputs at SMTS created an imbalance between the currents in the relays at two ends of the line (SMTS and KTS), resulting in the operation of the ‘Y’ current differential protection on the line. Operation of the ‘Y’ protection resulted in both direct and CB Fail⁷ trip signals being sent to the associated CBs at SMTS, KTS and ROTS.

No CBs were tripped at KTS, because both the main and CB Fail trips had been correctly isolated earlier in the morning as part of isolation of the Y protection relay. However, although the main trips at SMTS had been correctly isolated, the CB Fail trip links at SMTS were not included in the isolations carried out earlier. As a consequence, the CB Fail timers timed out after 100 ms, and CB Fail commands were initiated to both the CBs between:

- SMTS No1 500 kV busbar and SMTS–KTS 500 kV line (CB 207).
- SMTS–KTS 500 kV line and SMTS–ROTS No3 500 kV line (CB 208).

For a CB Fail command to initiate a trip, the current through the CB must exceed a specified threshold. The current through CB 208 exceeded the threshold, and trip commands were issued to the following CBs between:

- SMTS No1 500kV busbar and SMTS–KTS 500 kV line (CB 207).
- SMTS No2 500kV busbar and SMTS–ROTS No3 500 kV line (CB 209) and
- The tie and bus CBs at ROTS associated with the SMTS–ROTS No3 500 kV line.

The current through CB 207 did not exceed the threshold, so no further CB operations occurred.

All elements were returned to service by 1307 hrs.

While the initial isolations carried out to remove a faulty relay from the service were considered suitable for this work, additional isolation should have been done prior to relay testing when the replacement relay was being commissioned.

The procedures relating to isolation requirements during the initial fault investigation and the follow-up repair work have been re-iterated to all AusNet field staff.

⁶ A transmission may remain in service with only a single protection system in service for up to 24 hours – AEMO, *Power System Security Guidelines* (SO_OP 3715), Section 16.3.

⁷ A CB Fail trip is a back-up trip signal that initiates a trip if the main trip signal has failed to open the CB in a specified timeframe – 100 ms in this case. The CB Fail trip assumes the CB in question is unable to open and will open all surrounding CBs to clear the fault.

4. 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.⁸

This section assesses how AEMO managed power system security over the course of this incident.

AEMO invoked constraint set V-ROSM⁹ from 1245 hrs, approximately eight minutes after the lines were offloaded. AEMO invoked constraint set V-KTSM_R¹⁰ from 1250 hrs, approximately 13 minutes after the lines were offloaded. This action ensured that the power system returned to and then was maintained in a secure operating state. Both constraints were revoked at 1315 hrs, eight minutes after the lines had been restored to service.

AEMO issued Market Notice 59108 at 1320 hrs, approximately 43 minutes after the trip of the lines, to notify the market of a non-credible contingency event.¹¹

No further action was required to maintain power system security.

4.1 Reclassification

After the lines were returned to service, AEMO assessed whether or not to reclassify the event as a credible contingency.¹² For this incident, AEMO was satisfied that the cause had been identified and that the incident was unlikely to reoccur. Market Notice 59108 issued at 1320 hrs included information to notify the market that the incident would not be reclassified as a credible contingency.

For this incident, the power system remained in a secure operating state over the course of the incident. AEMO correctly assessed the incident and did not reclassify the incident as a credible contingency, and appropriate notifications were issued.

5. 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 over the course of this incident.

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

1. A non-credible contingency event - notify within two hours of the event.¹³
 - AEMO issued Market Notice 59108 at 1320 hrs, 43 minutes after the lines were offloaded.
2. Constraints invoked with interconnector terms on the left hand side (LHS).¹⁴
 - AEMO issued Market Notice 59109 at 1322 hrs, 45 minutes after the lines were offloaded, with information that constraint sets V-ROSM and V-KTSM_R had been invoked from 1245 hrs and 1250 hrs respectively to 1315 hrs.

Over the course of this incident, AEMO issued appropriate, timely, and sufficiently detailed market information.

⁸ 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

⁹ Outage = Rowville to South Morang 500 kV line.

¹⁰ Outage = Keilor to South Morang 500 kV line, Radial mode

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* (SO_OP 3715), Section 10.3. Market Notices, published as operating incidents progress, are available on AEMO's website at <https://www.aemo.com.au/Market-Notices>.

¹² 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.

¹³ AEMO is required to notify the Market of a non-credible contingency event within two hours of the event – AEMO, *Power System Security Guidelines* (SO_OP 3715), Section 10.3.

¹⁴ For short-term outages, AEMO is required to notify the Market of variances to interconnector transfer limits – AEMO, *Power System Security Guidelines* (SO_OP 3715), Section 22.



6. 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:

- This incident occurred due to inadequate isolation during testing of protection equipment when a faulty relay was being replaced and recommissioned.
- The procedures relating to the protection isolation requirements during the initial fault investigation and the follow-up repair/rectification work have been reiterated to all AusNet field staff.
- The power system remained in a secure operating state over the course of the incident.

APPENDIX A. POWER SYSTEM DIAGRAM

This figure shows the relevant section of the power system immediately after the incident

