AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Trip of Multiple Transmission Elements at Ross Substation on 22 May 2018

November 2018

Reviewable operating incident report under the National Electricity Rules

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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INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1001 hrs on 22 May 2018
Region of incident	Queensland
Affected regions	Queensland
Event type	Protection maloperation
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	Direction to Queensland Generators – 22 May 2018, available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events/Market-event-reports.

ABBREVIATIONS

Classification	Detail
AC	Alternating current
AEMO	Australian Energy Market Operator
CB	Circuit Breaker
CT	Current Transformer
DC	Direct current
kV	Kilovolt
NER	National Electricity Rules

Contents

1. Overview

This report relates to a reviewable operating incident (being a non-credible contingency event)[1] that occurred on Tuesday, 22 May 2018 at Ross substation in Queensland. This incident involved the near simultaneous trip of multiple transmission elements during planned work on the secondary wiring of the 8858 Strathmore 275 kV No. 1 bus isolator 88583 (Isolator 88583). These elements were:

- No. 2 275/132 kV Transformer (No.2 Transformer).
- No. 3 275/132 kV Transformer (No.3 Transformer).
- No. 4 275/132 kV Transformer (No.4 Transformer).
- 8858 Strathmore 275 kV line Reactor (8858 Line Reactor).
- No. 2 275 kV Reactor (No.2 Reactor).
- No .1 275 kV Static Var Compensator (No.1 SVC).

There was no loss of generation or 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 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:

1. The trip of the transmission equipment at Ross substation was caused by a voltage transient on the 125 V DC system. This voltage transient occurred during planned work on secondary system wiring and was caused by a pre-existing wiring error in the heating element circuitry of an isolator control cubicle.
2. The power system remained in a satisfactory operating state and was returned to a secure operating state within 27 minutes.
3. AEMO issued a direction to a Scheduled Generator under clause 4.8.9 of the NER[3], to restore the power system to a secure operating state in accordance with clause 4.2.6 of the NER.
4. The cause of this incident was identified and AEMO was satisfied that a reoccurrence of this incident was unlikely, therefore the incident was not reclassified as a credible contingency.
5. AEMO provided appropriate and timely advice to the market in relation to this event.

This report is prepared in accordance with clause 4.8.15 of the National Electricity Rules (NER). It is based on information provided by Powerlink and from AEMO's own systems.

2. Prior conditions

Prior to this incident, the Ross – Chalumbin 857 275 kV line was out of service for planned work. Constraint set Q-RSCH[4] was invoked.

[1] See NER clause 4.8.15(a)(1)(i) and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

[2] See NER clause 4.8.15(b).

[3] Direction Report available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events/Market-event-reports.

[4] Out=857 or 858 Ross-Chalumbim 275kV line. CQ-NQ and FNQ stability limits.

3. The incident

On Tuesday, 22 May at 1002 hrs, the following equipment at Ross substation tripped during planned secondary systems wiring work in a field marshalling kiosk[5].

- No. 2 Transformer.
- No. 3 Transformer.
- No. 4 Transformer.
- 8858 Line Reactor.
- No. 2 Reactor.
- No. 1 SVC.

There was no high voltage fault on the power system and no generation or customer load was lost as a result of this incident. All transmission equipment was returned to service by 1038 hrs on 22 May 2018.

Refer to Appendix A1 for diagrams of the power system before and immediately after the incident.

During the course of this incident, AEMO issued directions in respect of two generating units in North Queensland to restore the power system to a secure operating state. A separate direction report has been published under clause 3.13.6A of the NER[6].

As the probability of multiple transmission elements tripping simultaneously is very low, it is considered a non-credible contingency event[7].

4. Powerlink investigation

The following is based on information provided by Powerlink as transmission network service provider (TNSP) for the area in question.

Prior to this incident, all equipment at Ross substation was in service and planned minor work on secondary system wiring associated with Isolator 88583 was being undertaken in a field marshalling kiosk.

During the course of this planned work, a link between the 240 V AC and 125 V DC supplies, which would normally be isolated from each other, to the marshalling kiosk was unexpectedly created due to a pre-existing wiring error in the heating element in an isolator control cubicle.

The link between the AC and DC systems caused a voltage transient on the 125 V 'X' battery system. This voltage transient impacted the inputs to some of the protection relays supplied by this battery system resulting in the simultaneous trip of Nos. 2, 3, and 4 Transformers, and the No. 2 and 8858 line reactors.

Approximately 11 seconds later, the No. 1 SVC tripped due to loss of auxiliary supply to its cooling system. The auxiliary supply to the cooling system is fed from the No. 3 and No. 4 transformers. Prior to the transmission equipment being returned to service, the AC and DC supplies to isolator 88583 were isolated. All transmission equipment was returned to service by the times shown in Table 1.

[5] Wiring junction box.

[6] Available at http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events/Market-event-reports.

[7] See NER clause 4.2.3.

Table 1 Return to service times

Equipment	Return to service time on 22 May 2018
No. 3 Transformer	1029 hrs
No. 4 Transformer	1029 hrs
No. 2 Transformer	1032 hrs
No. 1 SVC	1034 hrs
No. 2 Reactor	1038 hrs
8858 Line Reactor	1038 hrs

After the transmission equipment was returned to service, the wiring error was identified and corrected, and the AC and DC supplies to Isolator 88583 restored.

5. 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].

Immediately after the incident the power system was in a satisfactory operating state but was not in a secure operating state. AEMO's contingency analysis tools indicated post-contingent thermal and voltage violations for a large number of single contingencies in Far North Queensland.

AEMO considered the constraint sets it had available, and determined that, due to the outage of multiple transmission elements, no suitable constraint sets were available.

After discussions with Powerlink, AEMO determined the best solution to return the power system to a secure operating state was to limit the flow across the Ross cut-set[9] to a maximum of 200 MW. AEMO invoked constraint set Q-RS_200[10] from 1015 hrs[11].

Immediately prior to this incident the flow across the Ross cut-set was approximately 350 MW.

Table 2 shows the dispatch targets for generating units in Far North Queensland[12] in response to constraint set Q-RS_200.

[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] Sum of flow on 275 kV lines 879, 885, and 8858 at Ross, 132 kV line 7128/2 at Collinsville, and 132 kV line 7208 at Strathmore.

[10] Flow across Ross cut-set less than or equal to 200 MW.

[11] Dispatch interval ending 1020 hrs.

[12] Other generating units in North Queensland were either already at full output or were not available for service.

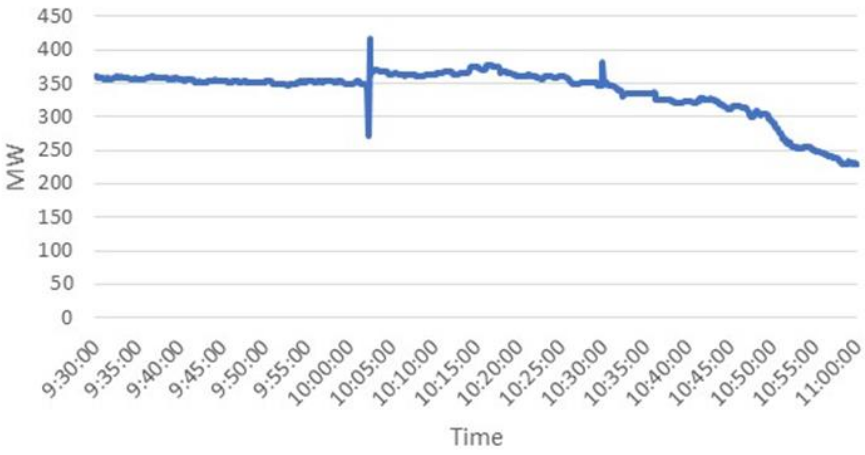
Table 2 Dispatch targets

Generating unit	Dispatch target DI 1015 hrs	Dispatch target DI 1020 hrs	Dispatch target DI 1025 hrs
Barron Gorge 1	0 MW	Synchronising	Synchronising
Barron Gorge 2	0 MW	Synchronising	Synchronising
Mt. Stuart 1	0 MW	Synchronising	Synchronising
Mt. Stuart 2	0 MW	Synchronising	Synchronising
Yabulu	0 MW	Synchronising	Moving to minimum load (69 MW)

On receipt of the dispatch targets for the Mount Stuart generating units and the Yabulu generating unit, AEMO was advised by the asset owners that it was not economical for the generating units to follow targets and the generating units would be bid unavailable from the 1030 hrs dispatch interval. As there were no other options to reduce the flow across the Ross cut-set and return the power system to a secure operating state, AEMO issued a direction[13] to Origin Energy in respect of the Mount Stuart 1 and Mount Stuart 2 generating units to synchronise and follow dispatch targets at 1025 hrs. The Barron Gorge generating units complied with their dispatch targets and increased to full output.

At 1029 hrs, Powerlink restored the No. 3 and No. 4 Transformers to service. This action returned the power system to a secure operating state before the flow across the Ross cut-set was substantially reduced. Figure 1 shows the Ross cut-set flow.

Figure 1 Ross cut-set flow



The Direction to the Mount Stuart generating units was cancelled at 1105 hrs and constraint set Q-RS_200 was revoked at 1110 hrs.

5.1 Reclassification

AEMO assessed whether to reclassify this incident as a credible contingency event[14].

[13] In accordance with NER clause 4.8.9. Refer to the Directions Report for more information about the Direction.

[14] AEMO is required to assess whether 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).

At 1025 hrs, before the transmission equipment was returned to service, Powerlink advised AEMO the cause of the incident had been identified and remedial action taken to prevent a re-occurrence. Based on this information, AEMO and was satisfied that the cause had been identified and the incident was unlikely to reoccur. AEMO therefore determined not to reclassify this incident as a credible contingency event.

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[15] 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[16].
   - AEMO issued Market Notice 62895 at 1033 hrs – 31 minutes after the event.
2. Advice that AEMO had issued a direction
   - AEMO issued Market Notice 62897 at 1052 hrs to advise the market that a direction had been issued to a participant in the Queensland Region for power system security reasons.
3. Advice that AEMO had declared an intervention event
   - AEMO issued Market Notice 62898 at 1120 hrs to advise the Market that AEMO had declared an intervention event from 1030 hrs to 1110 hrs.
4. Cancellation of direction
   - AEMO issued Market Notice 62899 at 1105 hrs to advise that the direction had been cancelled from 1105 hrs.
5. Advice about reclassification
   - AEMO issued Market Notice 62902 at 1137 hrs to advise that the cause of the non-credible contingency had been identified and AEMO would not reclassify the event as a credible contingency event.

AEMO issued appropriate, timely, and sufficiently detailed market information in relation to this event.

7. Conclusions

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 transmission equipment at Ross substation was caused by a voltage transient on the 125V DC system. This voltage transient occurred during planned work on secondary system wiring and was caused by a pre-existing wiring error in the heating element circuitry of an isolator control cubicle.

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

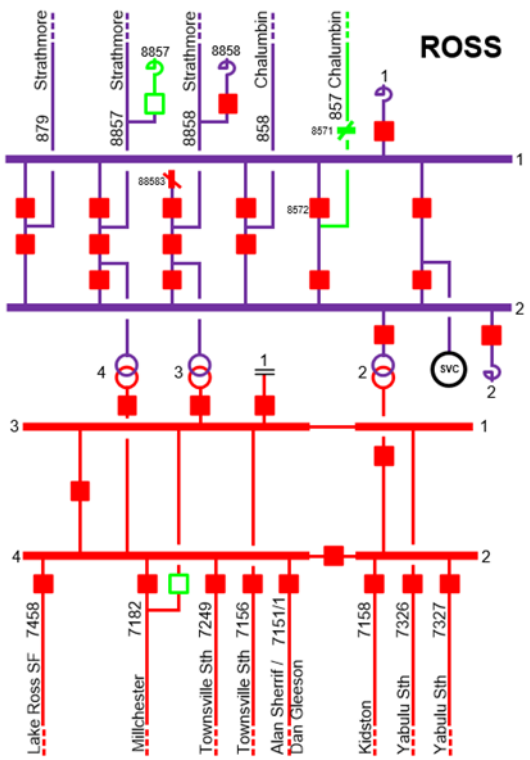
[16] AEMO is required to notify the Market of a non-credible contingency event within two hours of the event – AEMO, Power System Security Guidelines, Section 10.3. Available at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3715---Power-System-Security-Guidelines.pdf.

2. The power system remained in a satisfactory operating state and was returned to a secure operating state within 27 minutes.
3. AEMO issued a direction to a Generator to restore the power system to a secure operating state in accordance with clause 4.2.6 of the NER.
4. The cause of this incident was identified and AEMO was satisfied that a reoccurrence of this incident was unlikely, therefore the incident was not reclassified as a credible contingency event.
5. AEMO provided appropriate and timely advice to the market in relation to this event.

A1. Power system diagram

The diagrams below should the status of switchgear at Ross substation before and immediately after this incident.

Before



After