



Trip of Wandoan South to Yuleba North 8898 and 8899 275 kV lines on 7 December 2020

April 2021

Reviewable Operating Incident Report under the
National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of Incident	1530 hrs on 7 December 2020
Region of incident	Queensland
Affected regions	Queensland
Event type	Protection-control system mal-operation
Generation impact	Nil
Customer load impact	There was a 177 MW load drop off due to voltage reduction during fault
Associated reports	Nil

ABBREVIATIONS

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
kV	Kilovolt
NEM	National Electricity Market
NER	National Electricity Rules
SPAR	Single phase auto-reclose
TNSP	Transmission Network Service Provider

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.

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1. Overview

This report relates to a reviewable operating incident¹ that occurred on 7 December 2020 in Queensland. The incident involved the simultaneous single phase trip and auto-reclose of the 8899 Wandoan South – Yuleba North 275 kilovolt (kV) line (line 8899) and the 8898 Wandoan South – Yuleba North 275 kV line (line 8898). These lines are dual circuit construction, meaning they share common towers for the entire length of the lines.

No customer load was disconnected from the wider power system as a result of this incident, however due to the voltage reduction associated with the disturbance, there was a 177 megawatts (MW) customer load drop off.

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 security².

AEMO has concluded that:

1. The single phase trip and auto-reclose of line 8899 was caused by lightning, and protection systems operated as designed to clear the fault.
2. The single phase trip and auto-reclose of line 8898 was caused by unexpected protection operation.
3. The root cause of the unexpected protection operation was a feeder Y relay stability issue that manifests itself under weak infeed scenarios. Powerlink has advised that temporary setting changes were made on 8 December 2020 to the relevant relays on line 8899 and line 8898 to remove the risk of re-occurrence. Powerlink is seeking manufacturer feedback on the appropriate long-term solution to address this issue.
4. 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 Powerlink and AEMO.

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

2. The incident

2.1 Pre-incident conditions

Prior to this incident, AEMO and Powerlink³ were aware of lightning activity in the area of line 8899 and line 8898. In accordance with AEMO's Power System Security Guidelines⁴, AEMO was not required to reclassify the simultaneous loss of both lines as a credible contingency, as both lines had no history of tripping simultaneously due to lightning.

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 Powerlink is the Transmission Network Service Provider (TNSP) for Queensland.

⁴ Refer to Section 8.4 of the guidelines 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.

2.2 The incident

At 1530 hrs on 7 December 2020, a lightning strike resulted in tripping of 'A' phase of line 8899. Coincident with this lightning strike, a protection mal-operation tripped the 'A' phase on line 8898. Phase 'B' and 'C' of both lines remained in service during this incident. The 'A' phase of both lines successfully auto-reclosed within six seconds.

2.3 Analysis

The following is based on information provided by Powerlink.

A high voltage phase to ground fault occurred on the 'A' phase conductor of the 275 kV line 8899 as a result of a lightning strike. The protection systems on line 8899 operated as expected to clear the fault by tripping only the "A" phase conductor within 80 milliseconds. Powerlink has also confirmed the lightning protection on line 8899 has no known condition issues.

At the same time, line 8898 Y protection at Yuleba North sent a momentary trip signal to the phase 'A' circuit breaker at Yuleba North. Upon receipt of this trip signal, the 'A' phase of the Yuleba North circuit breaker for line 8898 opened. This left phase 'A' of line 8898 disconnected at Yuleba North but still energised from the Wandoan South end. The open phase on both line 8899 and 8898 successfully auto-reclosed within six seconds.

As a result of these concurrent single phase outages (and the radial nature of the network connected to Yuleba North), the phase 'A' high voltage supply to the network downstream of Yuleba North was lost during the auto-reclose deadtime of five seconds. During and shortly following the outages a 177 MW customer load drop off occurred, caused by the interruption to the 'A' phase voltage.

Powerlink's initial feedback was that the incident had been caused by lightning strike causing a single phase 'A' to ground fault on line 8899 with subsequent backflash on line 8898.

During the post-incident investigation on 8 December 2020, Powerlink assessed the performance of the line 8898 Y protection relay at Yuleba North and identified the cause of the line 8898 trip at that site as a relay stability issue. The identified issue manifests itself in rare circumstances under low fault level scenarios and has been referred to the relay manufacturer. Temporary setting changes were applied on the afternoon of 8 December 2020 to all Y protection relays at both ends of line 8899 and line 8898 to mitigate the risk of re-occurrence. Feedback is being sought from the relay manufacturer to confirm the appropriate long-term solution to this relay stability issue.

Powerlink confirmed that a review has been completed to determine if there are any other implementations of this type of relay at risk of a similar performance issue across its network. No other relays at risk in Powerlink's network have been identified.

3. 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 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 NER⁵.

The power system was in a secure operating state throughout this incident, and no action was required by AEMO to restore or maintain power system security.

⁵ 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.

3.1 Reclassification

AEMO assessed whether to reclassify this incident as a credible contingency event⁶.

AEMO's Power System Security Guidelines state that any successful simultaneous single phase auto-reclose (SPAR) operation on multiple lines does not require AEMO to reclassify the loss of the multiple lines as a credible contingency⁷. During this incident, the AEMO control room and Powerlink could not confirm how many phases of each circuit had tripped and auto-reclosed until Powerlink site staff were able to get more information from protection relay logs at Yuleba North and Wandoan South substations.

Given the information available at the time and the significant lightning activity in the area, AEMO correctly reclassified the simultaneous trip of line 8899 and 8898 as a credible contingency at 1626 hrs on 7 December 2020, pending Powerlink's investigation into the cause and events.

Powerlink's initial feedback was that the incident had been caused by a lightning strike causing a single phase 'A' to ground fault on line 8899 with subsequent backflash on line 8898. In addition, Powerlink advised that this event was unlikely to re-occur. Based on this information, the incident reclassification was cancelled at 1723 hrs on 7 December 2020.

Powerlink's assessment of the protection operations determined the true cause of the 8898 line trip as the relay stability issue on the morning of 8 December 2020. AEMO did not reassess the requirement to reclassify this event as a credible contingency at this time, as AEMO was unaware of the newly identified cause of the incident. Powerlink implemented the temporary setting changes to mitigate the risk of re-occurrence on the afternoon of 8 December 2020. To confirm, the power system remained in a secure state throughout the period between the initial fault and Powerlink's setting changes.

4. 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 market⁸ 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 event⁹.
 - AEMO issued Market Notice 80893 at 1559 hrs on 7 December 2020, 29 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 practical¹⁰.
 - AEMO issued Market Notice 80896 at 1626 hrs on 7 December 2020 to advise that AEMO had reclassified the incident as a credible contingency.
 - AEMO issued Market Notice 80900 at 1723 hrs on 7 December 2020 to advise that AEMO had cancelled the reclassification of the incident as a credible contingency.

⁶ 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).

⁷ See Appendix A1 for more information on SPAR protection system operation.

⁸ AEMO generally informs the market about operating incidents as they progress by issuing Market Notices – see <https://www.aemo.com.au/Market-Notices>.

⁹ 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 7.3.

¹⁰ 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).

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 single phase trip and auto-reclose of the line 8899 was caused by lightning, and the protection systems associated with line 8899 operated as designed to clear the fault.
2. The single phase trip and auto-reclose of line 8898 at Yuleba North was caused by unexpected protection operation of this line's feeder Y protection at that site.
3. The root cause of the unexpected protection operation was a feeder Y relay stability issue that manifests itself under weak infeed scenarios. Powerlink has advised that temporary setting changes were made on 8 December 2020 to the relevant relays on line 8899 and line 8898 to remove the risk of re-occurrence. Powerlink is seeking manufacturer feedback on the appropriate long-term solution to this issue.
4. The power system remained in a secure operating condition throughout this incident.

6. Recommendations

It is recommended that Powerlink share details of the cause of this incident with other network service providers (NSPs) through the Power System Security Working Group. NSPs should check their own networks are not susceptible to a similar unexpected protection operation.

All NSPs should inform AEMO as soon as possible of any updated information that could change the likelihood of a non-credible contingency event occurring. This will allow AEMO to assess whether to remove or instate reclassifications.

A1. Auto-reclose operations

Single phase auto-reclose (SPAR) increases the reliability of transmission systems. When a single phase to ground fault occurs, only that phase is tripped and then automatically reclosed after a defined time delay to allow time for intermittent faults to clear. If the auto-reclose fails because the fault is still present, then the other two phases are also tripped, and no further auto-reclosing takes place.

If a phase to phase fault or a multi-phase to ground fault occurs, all three phases are tripped and then automatically reclosed after a defined time delay. Similarly, if the fault is still present on the line, all three phases will be tripped with no further auto-reclosing. On non-SPAR-equipped lines, a single phase to ground fault will result in the trip of all three phases. Auto-reclosing, if enabled, will then occur on all three phases.