
Trip of Davenport – Bungama 275 kV Line and Davenport East 275 kV Busbar on 23 October 2020

February 2021

Reviewable Operating Incident Report under the
National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of Incident	14:42 hrs on 23 October 2020
Region of incident	South Australia
Affected regions	South Australia
Event type	Lightning, protection-control system failure or mal-operation
Generation impact	Nil
Customer load impact	Nil
Associated reports	Nil

ABBREVIATIONS

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
NEM	National Electricity Market
NER	National Electricity Rules
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 23 October 2020 in South Australia. The incident involved the trip of Davenport – Bungama 275 kilovolt (kV) line (Davenport – Bungama line) and the Davenport 275 kV East Bus.

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 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 Davenport – Bungama line tripped due to a single phase to earth fault caused by a lightning strike.
2. The Davenport 275 kV East bus tripped due to the unexpected operation of circuit breaker (CB) Fail protection on CB 6560.
3. The root cause of the unexpected operation of the CB Fail protection was incorrect wiring between the CB Management/auto-reclose panel and CB 6560. The wiring error was corrected before the CB was returned to service.
4. The power system remained in a secure operating state.

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 ElectraNet³ and AEMO.

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

2. The incident

2.1 The incident

At 14:42 hrs on 23 October 2020, a lightning strike caused a single phase to earth fault on the Davenport – Bungama line. This fault was detected by the protection systems and issued single pole tripping to CB 6561 and CB 6560 at Davenport and CB 6537 at Bungama, which opened the single phase of the Davenport – Bungama line and then initiated reclose operation.

However, before completing the reclose operation of the Davenport – Bungama line, CB Fail protection on CB 6560 at Davenport operated resulting in the three phase trip of the Davenport- Bungama line and a trip of the Davenport 275kV East Bus, which also offloaded the 275kV connection to the Davenport No. 2 275/132 kV transformer (No. 2 transformer).

The Davenport East Bus and No. 2 transformer were restored by 16:36 hrs on 23 October 2020 and the Davenport – Bungama line was restored at 20:08 hrs on 23 October 2020. The Davenport CB 6560 was restored to service at 08:10 hrs on 24 October 2020.

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 ElectraNet is the transmission network service provider (TNSP) in South Australia.

2.2 Analysis

The following is based on information provided by ElectraNet.

At 14:42 hrs on 23 October 2020, a lightning strike close to tower STR0789 caused a 'U' phase⁴ to earth fault on the Davenport – Bungama line. Both the X and Y protection systems detected this fault and issued single-phase tripping to CB 6561 and CB 6560 at Davenport and CB 6537 at Bungama which opened the single phase of the Davenport – Bungama line and then initiated the auto-reclose function. Protection relays also tripped all phases of CB 6538 at Bungama without initiating reclose as per design. All protection relays correctly identified the line fault and operated as expected.

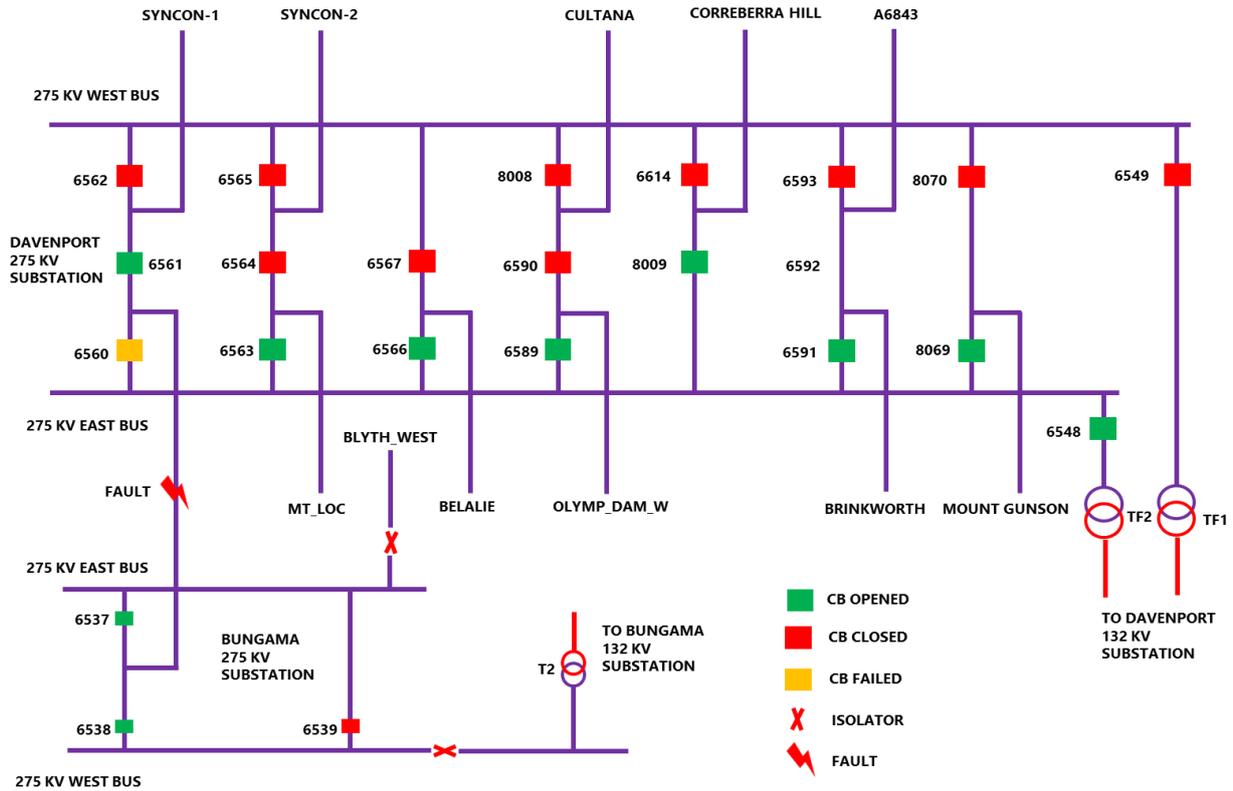
However, before the completion of the reclosure operation, CB Fail protection on Davenport CB 6560 operated, resulting in the three-phase tripping of CB 6561 and the 275 kV East Bus CBs at Davenport. This resulted in the tripping of Davenport 275 kV East Bus, which also offloaded the 275 kV connection to the No. 2 transformer. The CB Fail protection also sent a direct intertrip signal from Davenport to Bungama, which tripped the remaining in service phases of CB 6537. The operation of the CB Fail protection was not an expected outcome for the fault on the Davenport – Bungama line.

After the event, CB 6560 at Davenport was isolated, and the Davenport East Bus and No. 2 Transformer were placed on load by 16:36 hrs on 23 October 2020. A ground patrol of Davenport – Bungama line was completed as per ElectraNet's normal procedures, and the line was restored at 19:38 hrs on 23 October 2020.

Analysis by ElectraNet determined the unexpected operation of the CB Fail protection of CB 6560 was due to incorrect wiring between the Davenport – Bungama line protection relays at Davenport and the trip coils for CB 6560. The 'U' and 'W' phase trips from the Bungama line protections were incorrectly connected to the 'W' and 'U' phase trip coils of CB 6560 respectively. Therefore, a 'U' phase fault on the Davenport – Bungama line would result in a 'W' phase trip of CB 6560.

⁴ U-V-W phase sequence is equivalent to A-B-C or R-W-B or R-Y-B phase sequence.

Figure 1 Simplified post-fault single line diagram 275 kV Davenport substation and Bungama substation



During this event, 'U' phase on CB 6561 at Davenport opened correctly with fault current through the CB seen to cease after 40.6ms. However, on CB 6560 the 'W' phase opened instead of the 'U' phase which did not clear the fault on 'U' phase. As the fault was not cleared the CB Fail protection on CB 6560 was initiated resulting in the three-phase tripping of CB 6561, the CBs on the Davenport 275kV East Bus, and CB 6537 at Bungama.

ElectraNet confirmed that the error in the trip wiring occurred during the replacement of CB 6560 and CB 6561 with new CBs during an aged asset replacement project that was completed on 30 July 2020.

In the case of CB 6561, the CB Management/auto-reclose panels was also replaced, and new trip wiring installed all the way from the CB back to the line protection panel. Testing of the new wiring from the protection panels to the CB trip coils was carried out to confirm the wiring changes. On CB 6560, the CB Management/auto-reclose panels was not replaced and testing was only carried out between the existing CB Management/auto-reclose panels and the CB, resulting in the wiring error not being detected, as testing were not carried out on the existing protection wiring.

ElectraNet confirmed that the commissioning engineers and design staff have been made aware of this error and the requirement that single-pole tripping circuits be proved from the outputs of line protection relays to individual circuit breaker poles to ensure that correct phase tripping occurs in the event of a line fault. ElectraNet also confirmed that no similar wiring issues are present in any of the 275 kV CBs that were replaced since 2015 for which single phase tripping is enabled.

The trip circuit for CB 6560 was corrected and tested for correct operation and CB 6560 was returned to service at 08:10 hrs on 24 October 2020.

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 prior to and during this incident and AEMO was not required to take any action in relation to power system security.

3.1 Reclassification

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

AEMO was advised by ElectraNet that the cause of the incident had been identified and the failed equipment had been isolated prior to restoration of the busbar. As such, AEMO correctly did not classify this non-credible contingency as a credible contingency event.

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 market⁷ 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 event⁸.
 - AEMO issued Market Notice 79126 at 15:07 hrs on 23 October 2020, 25 minutes after the event, to advise of the non-credible contingency event.
2. Constraints invoked with interconnector terms on left hand side⁹.
 - AEMO issued Market Notice 79127 at 15:17 hrs on 23 October 2020 to advise it had invoked constraint set S-BGDV. This constraint set was invoked due the outage of Davenport – Bungama line and it contains constraint equations with the V-S-MNSP1 interconnector on the LHS.
3. Update – non-credible contingency event
 - AEMO issued Market Notice 79139 at 17:39 hrs on 23 October 2020, to advise of the cause of this non-credible contingency event had been identified and AEMO was satisfied that another occurrence of this event was unlikely under the current circumstances.

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.

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

⁸ 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.

⁹ 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 Davenport – Bungama line tripped due to a single phase to earth fault caused by a lightning strike.
2. The Davenport 275 kV East bus tripped due to the unexpected operation of CB Fail protection on CB 6560.
3. The root cause of the unexpected operation of the CB Fail protection was incorrect wiring between the CB Management/auto-reclose panel and CB 6560. The wiring error was corrected before the CB was returned to service.
4. The power system remained in a secure operating state.