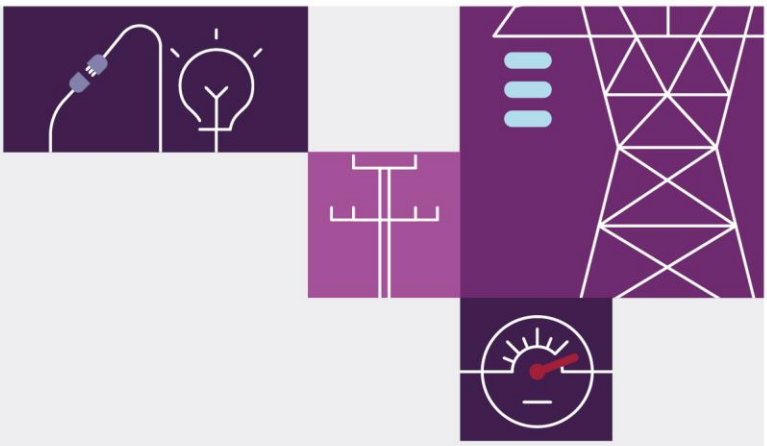
Trip of multiple transmission elements at Davenport 275 kV substation

March 2022

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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Contact

If you have any questions or comments in relation to this report, please contact AEMO at system.incident@aemo.com.au.

The NEM operates on Australian Eastern Standard Time (AEST). All times in this report are in AEST.

Abbreviations

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CB	Circuit Breaker
kV	Kilovolt
MW	Megawatts
NEM	National Electricity Market
NER	National Electricity Rules
TNSP	Transmission Network Service Provider

Incident review

This reviewable operating incident[1] report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It has been prepared using information provided by ElectraNet[2] and from AEMO systems.

Table 1 Summary of event

	Details
Reviewable operating incident type	Non-credible contingency event impacting critical transmission elements.
Incident details	This report relates to a reviewable operating incident[3] that occurred on 28 September 2021 in South Australia. The incident was a non-credible contingency event involving the simultaneous trip of the Davenport – Bungama 275 kV line, the Davenport 275 kV West Bus, the Davenport – Mount Lock 275 kV line, and the Davenport No. 2 Synchronous Condenser.
Incident classification	Protection/control system – mal-operation of protection system.
Generation impact	No generation was lost as a result of this incident.
Customer load impact	No load was lost as a result of this incident.
Pre-incident conditions	Prior to the event, all transmission lines from Davenport 275 kV substation were in service, the Davenport No.1 Synchronous Condenser was offline, and the Davenport No. 2 Synchronous Condenser was online.
Incident key events	1. At 1555 hrs on 28 September 2021, a lightning strike caused a U phase fault on the Bungama – Davenport 275 kV line. The fault was cleared within 61 ms. Subsequently (between 196 ms and 227 ms after the fault was cleared) the following elements tripped: – The Davenport 275 kV West Bus. – The Davenport No. 2 Synchronous Condenser. – The Davenport – Mount Lock 275 kV line. 2. At 1730 hrs on 28 September 2021, the Davenport 275 kV West Bus and the Davenport – Mount Lock 275 kV line were returned to service. 3. At 2025 hrs on 28 September 2021, ElectraNet advised the cause of the incident had been identified and isolated and was unlikely to reoccur. 4. At 2031 hrs on 28 September 2021, the Davenport No. 2 Synchronous Condenser was returned to service.
Incident cause	Post incident investigation by ElectraNet has confirmed that: • The Bungama – Davenport 275 kV line distance and differential protection systems operated correctly clearing the fault caused by the lightning strike within 61 ms. • Subsequently, Circuit Breaker Fail (CBF) protection on circuit breakers CB6564 and CB6565 operated unexpectedly (see Figure 1). This CBF protection operation tripped the Davenport 275 kV West Bus, the Davenport – Mt Lock 275 kV line and the Davenport No. 2 Synchronous Condenser (see Figure 2). • At the time of the fault, the Davenport No. 2 Synchronous Condenser was in service and supplied approximately 1,000 A into the single-phase fault on the Bungama – Davenport 275 kV line. The resultant fault current caused an overload element to unexpectedly pickup in the Set 2 Davenport No. 2 Synchronous Condenser Generator Step-Up Transformer (GSUT) protection system. This transient overload element pickup caused the CBF protection on both CB6564 and CB6565 to erroneously pick up even though no trip signal had been sent to these circuit breakers.

[1] Reviewable operating incidents are defined by NER clause 4.8.15(a) and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

[2] ElectraNet is a Transmission Network Service Provider (TNSP) for South Australia.

[3] 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.

	Details
Power system response (facilities and services)	There were no other material impacts on the broader power system, load or generation.
Rectification	At 1920 hrs on 28 September 2021, ElectraNet disabled the overload protection in Davenport No. 2 Synchronous Condenser's GSUT Set 2 protection. Overload protection systems with identical settings have also been disabled at Davenport No. 1 Synchronous Condenser and Yadnarie Transformer 1. ElectraNet has confirmed that: • All protection systems with overload protection settings identical to the Davenport No.2 Synchronous Condenser have been disabled. • ElectraNet is reviewing the standard logic for this protection implementation to avoid similar issues in future protection systems that use the same logic. Until the review is complete, the overload protection for the Davenport Synchronous Condensers will be provided by their respective GSUT Set 1 protection systems. ElectraNet's review is expected to be completed in Q2 2022. • The Robertstown Synchronous Condensers' GSUT have different protection relays and protection settings to those used on the Davenport Synchronous Condensers. Therefore, the Robertstown Synchronous Condensers are not impacted by the settings issue identified by ElectraNet during this incident.
Power system security	The power system remained in a secure operating state throughout this incident and the Frequency Operating Standard[4] was met.
Reclassification	AEMO assessed whether to reclassify this incident as a credible contingency event[5]. At 1730 hrs, AEMO correctly reclassified the event as a credible contingency as the cause of the trip had not been identified. At 2025 hrs, ElectraNet advised that the cause of the trip had been identified and isolated. ElectraNet confirmed that the event was unlikely to re-occur, therefore AEMO cancelled the reclassification.
Market information	For this incident, AEMO issued the following market notices (all market notices for this incident were issued in accordance with NER requirements): • AEMO issued Market Notice 91270 at 1625 hrs on 28 September 2021 – Advice of non-credible contingency event. • AEMO issued Market Notice 91271 at 1740 hrs on 28 September 2021 – Reclassification of non-credible contingency event as credible contingency event. • AEMO issued Market Notice 91275 at 2219 hrs on 28 September 2021 – Cancellation of the reclassification of the non-credible contingency event as a credible contingency event from 2025 hrs on 28 September 2021.
Conclusions	AEMO has concluded that: 1. The single-phase fault on the Bungama – Davenport 275 kV line was caused by a lightning strike. The protection systems associated with this line operated correctly and cleared the fault. 2. The simultaneous trip of the Davenport 275 kV West Bus, the Davenport No. 2 Synchronous Condenser, and the Davenport – Mount Lock 275 kV line was caused by an incorrect operation of CBF protection due to an overload element pickup on the Davenport No. 2 Synchronous Condenser's GSUT Set 2 protection. 3. AEMO correctly identified the need to reclassify this incident as a credible contingency until the cause of the incident had been identified and isolated. 4. The power system remained in a secure operating state throughout this incident. 5. ElectraNet has confirmed that this issue is not present at the Robertstown Synchronous Condensers. 6. ElectraNet is reviewing the standard logic for this protection implementation to avoid similar issues in future protection systems that use the same logic. This review is expected to be completed in Q2 2022.

[4] Please see https://www.aemc.gov.au/sites/default/files/2020-01/Frequency operating standard - effective 1 January 2020 - TYPO corrected 19DEC2019.PDF

[5] 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).

Figure 1 Incident diagram prior to CBF protection operation

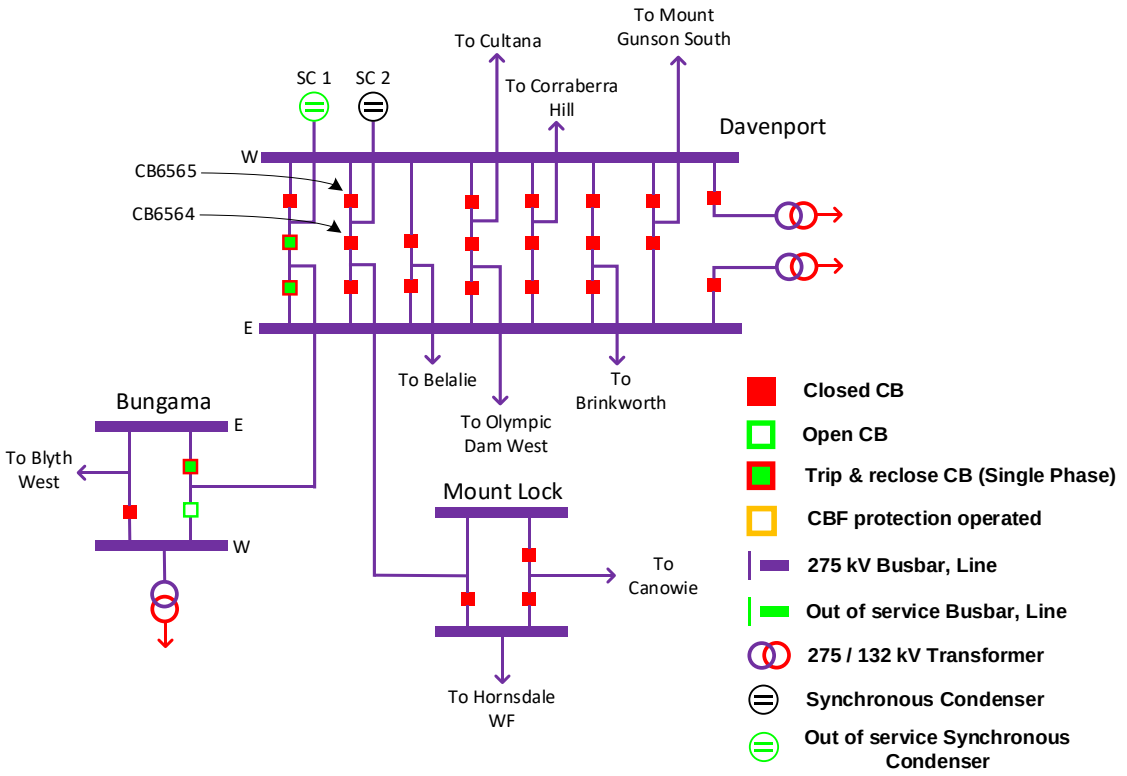

Figure 2 Post-incident diagram