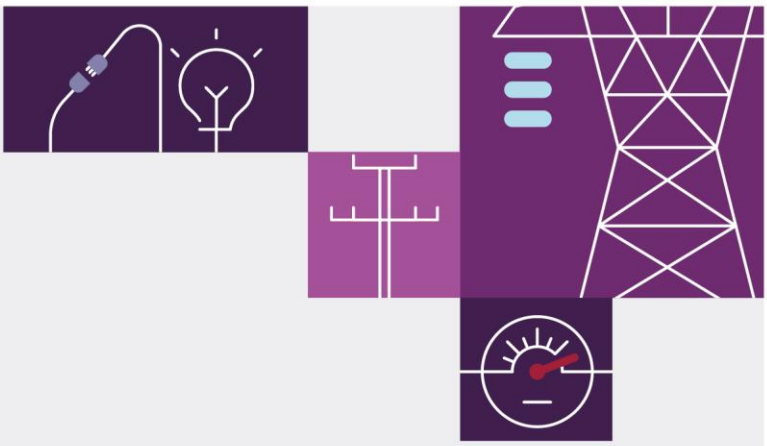
Trip of Braemar No. 4 275 kV busbar and Braemar – Western Downs 275 kV line 8820 on 29 November 2023

May 2024

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

To inform its review and the findings expressed in this report, AEMO has been provided with data by registered participants as to the status or response of some facilities before, during and after the reviewable incident, and has also collated information from its own observations, records and systems. Any views expressed in this report are those of AEMO unless otherwise stated, and may be based on information given to AEMO by other persons. AEMO has made reasonable efforts to ensure the quality of the information in this report but cannot guarantee its accuracy or completeness. Any views expressed in this report may be based on information given to AEMO by other persons.

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Abbreviations

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CB	circuit breaker
CBF	circuit breaker fail
CT	current transformer
kV	kilovolt/s
MW	megawatt/s
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 Powerlink[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 at 1421 hrs on 29 November 2023 in Queensland. This incident involved the trip of Braemar No. 4 275 kilovolt (kV) busbar and Braemar – Western Downs 275 kV line 8820.
Incident classification	Transmission equipment failure – 275 kV current transformer (CT) internal fault.
Generation impact	No generation was lost as a result of this event.
Customer load impact	No customer load was tripped or automatically shed in response to this incident.
Pre-incident conditions	Prior to the event, the Braemar substation 275 kV circuit breaker (CB) 50102 had just been returned to service at 1415 hrs on 29 November 2023 following a planned outage for routine oil sampling of its 275 kV CTs.
Incident key events	• At 1421 hrs on 29 November 2023, the Braemar No. 4 275 kV busbar tripped and the Braemar – Western Downs 275 kV 8820 line tripped, auto reclosed and tripped to lockout[4]. At the time of the incident, CB 50102 had been in service for approximately 6 minutes. • At 2040 hrs on 29 November 2023, the Braemar No. 4 275 kV busbar was returned to service. • At 1613 hrs on 1 December 2023, the Braemar – Western Downs 275 kV 8820 line was returned to service. • The Braemar substation 275 kV CB 50102 remained out of service until the B phase CT was replaced. Braemar 275 kV CB 50102 was returned to service on 25 January 2024.
Incident cause	Post incident investigation by Powerlink has confirmed: • At 1421 hrs on 29 November 2023, the Braemar No. 4 275 kV busbar and Braemar – Western Downs 275 kV 8820 line tripped due to an internal fault in the Braemar substation B phase CT associated with CB 50102. (See Figure 1). In addition, post incident investigation has confirmed the following protection and CB operations were recorded during the event: At Braemar substation: – Busbar protection operated and tripped CB 88602, CB 88612, CB 88622, CB 88632, CB 5422 and CB 50102 as expected. CB 50102 was also tripped by line protection as the CB 50102 CT fault was in the busbar and line protection zones. The busbar protection operated as expected. – The Braemar – Western Downs 275 kV line 8820 protection operated and tripped 275 kV CB 50102 and CB 88202 B phase as expected. – At Braemar, CB pole discrepancy tripped 275 kV CB 88202 A and C phase. This was not expected.

[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] Powerlink is a Transmission Network Service Provider (TNSP) for Queensland.

[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.

[4] The auto reclose function attempts to reenergise the line after the initial fault and will trip and lockout if the fault is persistent.

	Details
	– Line 8820 auto reclose sequence operated approximately 4 seconds later and closed CB 88202. As the CT fault was persistent line 8820 tripped and the auto reclose system locked out, as expected. At Western Downs substation: – Braemar – Western Downs 275 kV line 8820 protection tripped 275 kV CB 5032 and CB 88202 B phase only, as expected. – Braemar – Western Downs 275 kV line 8820 protection tripped 275 kV CB 88202 A and C phases as expected (opening all phases of CB 88202). This was a result of the subsequent high voltage fault occurring on C phase to earth of line 8820 conductors adjacent to the failed B phase CT associated with CB50102 at Braemar. Powerlink's investigation has concluded this was most likely caused by ionised gases from the initial fault. – Line 8820 auto reclose sequence operated approximately 4 seconds later and closed CB 88202. As the CT fault was persistent line 8820 tripped and the auto reclose system locked out, as expected.
Power system response (facilities and services)	There was no other material impact on the broader power system, load or generation.
Rectification	Powerlink replaced the Braemar substation B phase CT on 275 kV CB 50102. On 25 January 2024 the CB was returned to service. Powerlink, with input from the Original Equipment Manufacturer (OEM), are investigating the cause of the CT internal fault and plan to have this completed by the end of Q3 2024.
Power system security	The power system remained in a secure operating state throughout this incident and the Frequency Operating Standard[5] was met for this incident.
Reclassification	AEMO assessed whether to reclassify this incident as a credible contingency event[6]. The cause of this incident was identified and AEMO was satisfied that another occurrence of this event was unlikely under the current circumstances as the Braemar 275 kV CB 50102, and its failed B phase CT remained out of service. Further, on the 19 January 2024, Powerlink confirmed they have not observed this type of CT internal fault in other CTs. Powerlink replaced the failed CT at Braemar and CB 50102 was returned to service on 25 January 2024. Based on the information available to AEMO at the time, AEMO appropriately identified that reclassification was not required.
Market information	For this incident, AEMO issued the following market notices in accordance with NER requirements: • AEMO issued Market Notice 111848 at 1522 hrs on 29 November 2023 – Advice of non-credible contingency event in Queensland. At 1421 hrs on 29 November 2023 the Braemar No. 4 275 kV bus and Braemar – Western Downs 275 kV 8820 line tripped. • AEMO issued Market Notice 111854 at 1712 hrs on 29 November 2023 – Advice of the reclassification of the loss of all Darling Downs units and Darling Downs solar farm as a credible contingency from 1715 hrs on 29 November 2023 until further notice due to the concurrent outage of the Braemar No. 4 275 kV busbar and Braemar – Western Downs 275 kV 8820 line. • AEMO issued Market Notice 111864 at 2143 hrs on 29 November 2023 – Advice of the cancellation of the reclassification of a credible contingency under Market Notice 111854 as the Braemar No. 4 275 kV busbar was returned to service. AEMO's post-incident review has confirmed that constraint set Q-DD_DDSF_N-2 invoked between 1715 hrs and 2140 hrs on 29 November 2023 contains N-Q-MNSP1 and NSW1-QLD1 interconnector terms on the left hand side. The Power System Security Guidelines (SO_OP_3715)[7] indicate that AEMO should issue a market notice in these circumstances, however, AEMO did not issue the relevant market notice during this incident. While AEMO has reinforced the requirement to publish market notices in such circumstances, challenges with identifying the need for a market notice highlight the potential benefit of an automated solution.

[5] Frequency operating standard - effective 29 October 2023, available at https://www.aemc.gov.au/media/87484.

[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 Section 19 of the Power System Security Guidelines at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3715%20Power-System-Security-Guidelines.pdf.

	Details
Conclusions	AEMO has concluded that: 1. At 1421 hrs on 29 November 2023, the Braemar No. 4 275 kV busbar and the Braemar – Western Downs 275 kV 8802 line tripped due to an internal fault in the Braemar 275 kV CB 50102 B phase current transformer (CT). 2. The cause of the incident has been identified as transmission equipment failure – 275 kV CT internal fault. The root cause of the CT internal fault is still under investigation by Powerlink. 3. Powerlink are investigating the cause of the unexpected operation of the Braemar 275 kV CB 88202 pole discrepancy function. 4. The power system remained in a secure operating state throughout this incident.
Recommendations	1. AEMO supports Powerlink's precautionary approach to increase the oil sampling frequency for this make and model 275 kV CT, pending the results of the investigation into the root cause of the 275 kV CT internal fault. 2. Powerlink to share findings of the investigation of the cause of the 275 kV CT internal fault and any further recommended actions with AEMO and other TNSPs as appropriate by the end of June 2024. 3. Powerlink to share with AEMO the results of the investigation into the unexpected operation of the Braemar 275 kV CB 88202 pole discrepancy function by the end of May 2024. 4. AEMO has identified that the CT type which failed during this incident matches the CT type involved in recent reviewable operating incidents still under investigation involving CT failures in South Australia and is therefore engaging closely with Powerlink and ElectraNet to assess possible risks to power system security. 5. AEMO and Powerlink plan to share the findings from this event with the Power System Security Working Group (PSSWG) by Q3 2024.

Figure 1 Incident diagram (Braemar and Western Downs substations)