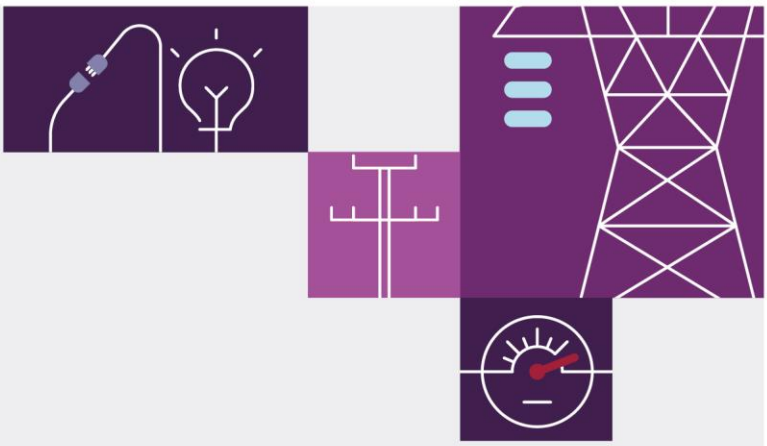
Trip of Strathmore 275 kV No. 2 busbar and Nebo – Strathmore 275 kV No. 878 line on 23 January 2024

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

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AEMO acknowledges the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters and culture. We pay respect to Elders past and present.

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
FOS	Frequency Operating Standard
kV	kilovolt/s
ms	milliseconds
NEM	National Electricity Market
NER	National Electricity Rules
OEM	original equipment manufacturer
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 0957 hrs on 23 January 2024 in Queensland. The incident involved the simultaneous trip of the Strathmore 275 kilovolt (kV) No. 2 busbar and the Nebo – Strathmore 275 kV No. 878 line.
Incident classification	Transmission equipment failure – 275 kV current transformer (CT) internal fault.
Generation impact	No generation was lost as a result of this incident.
Customer load impact	No customer load was tripped or automatically shed in response to this incident.
Previous incidents	A similar previous incident involving a 275 kV CT failure was reported in Queensland on 29 November 2023. This failure of a 275 kV CT associated with Braemar 275 kV circuit breaker (CB) 50102 caused the Braemar No. 4 275 kV busbar and Braemar – Western Downs 275 kV No. 8820 line to trip simultaneously. AEMO published a reviewable operating incident report for this previous incident[4].
Pre-incident conditions	Prior to the incident, Powerlink was undertaking line auto reclose testing of the Nebo – Strathmore 275 kV No. 878 line. The Strathmore 275 kV CB 5022 and Nebo 275 kV CB 5002 were open as part of the tests. There was an ongoing planned outage of Broadsound 275 kV CB 88312 in central Queensland at the time of the incident. This ongoing planned outage impacted the constraints invoked during this incident. Power system security for this planned outage was being managed by constraint set Q-BS_275BUS_CB.
Incident key events	1. At 0957 hrs on 23 January 2024, Strathmore 275 kV No. 2 busbar tripped and Nebo – Strathmore 275 kV No. 878 line tripped, auto reclosed and tripped to lockout[5] (see Figure 1). 2. At 1122 hrs on 23 January 2024, Strathmore 275 kV No. 2 busbar was returned to service. 3. At 1344 hrs on 23 January 2024, Nebo – Strathmore 275 kV No. 878 line was returned to service via Strathmore 275 kV CB 5022. The Strathmore 275 kV CB 8782 remained isolated. 4. At 1500 hrs on 23 January 2024, Broadsound 275 kV CB 88312 (which was taken out of service at approximately 0825 hrs on 23 January 2024 for a planned outage) was returned to service. 5. At 1202 hrs on 9 February 2024, following replacement of the B phase 275 kV CT, Strathmore 275 kV CB 8782 was returned to service.
Incident cause	Powerlink's post incident investigation has determined that: • Strathmore 275 kV No. 2 busbar and Nebo – Strathmore 275 kV No. 878 line tripped due to an internal fault in the B phase 275 kV CT associated with Strathmore 275 kV CB 8782 (See Figure 1). • The internal fault of the B phase 275 kV CT was within the Strathmore 275 kV No. 2 busbar protection zone and outside the Nebo – Strathmore 275 kV No. 878 line protection zone. Busbar protection operated as expected and tripped – Strathmore 275 kV CB 5012, 275 kV CB 8782, 275 kV CB 5032, 275 kV CB 88452, 275 kV CB 5422, 275 kV CB 8222, and 275 kV CB 5812. The fault remained uncleared, because the fault was still supplied via the Nebo – Strathmore 275 kV No. 878 line. As a result, circuit breaker fail (CBF)

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

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

[3] See NER 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] See https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2023/trip-of-braemar-275-kv-no-4-busbar-and-braemar-western-downs-no-8820-275-kv-line.pdf?la=en.

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

	Details
	protection associated with Strathmore 275 kV CB 8782 operated to trip Nebo – Strathmore 275 kV No. 878 line from Nebo end, effectively isolating the fault from the system. The total time to clear the fault was 210 milliseconds (ms), which satisfies the NER requirement that faults on the 275 kV network cleared by CBF protection should be cleared within 250 ms[6]. • Just prior to isolation of the fault by the operation of CBF protection, Nebo – Strathmore 275 kV No. 878 line distance protection equipment at Strathmore detected the fault in its forward direction. According to Powerlink's investigation, this was likely caused by the development of the CT's internal fault into the protection zone of the Nebo – Strathmore 275 kV No. 878 line. As a result, a permissive intertrip signal was sent from Strathmore to Nebo. The Nebo – Strathmore 275 kV No. 878 line distance protection equipment at Nebo had already detected the fault in its Zone 2. Because it also received a permissive intertrip signal from the Strathmore end, the distance protection equipment at Nebo operated to command tripping of the Nebo – Strathmore 275 kV No. 878 line from the Nebo end. By this time, the operation of CBF protection had already initiated the tripping of the Nebo – Strathmore 275 kV No. 878 line. However, the operation of line distance protection initiated the auto reclosure sequence of the Nebo – Strathmore 275 kV No. 878 line. • The Nebo – Strathmore 275 kV No. 878 line auto reclosed at the Nebo end approximately 5 seconds later and closed Nebo 275 kV CB 8782. As the CT fault was persistent, the Nebo – Strathmore 275 kV No. 878 line tripped and the auto reclose system locked out. All protection referred to in this section operated as expected.
Power system response (facilities and services)	There was no other material impact on the broader power system, load, or generation.
Rectification	The Strathmore 275 kV CB 8782 was isolated until Powerlink replaced the faulty B phase 275 kV CT on 9 February 2024. Powerlink, with input from the original equipment manufacturer (OEM) of the faulty 275 kV CT, is working to identify the root cause of the failure and plans to have this completed by the end of August 2024.
Power system security	Post incident, AEMO assessed the incident impact to power system security. The power system remained in a secure operating state throughout this incident and the Frequency Operating Standard (FOS)[7] was met for this incident. AEMO invoked constraint sets: • Q-BS_275BUS_CB prior to and throughout the incident to manage the ongoing planned outage of the Broadsound 275 kV CB 88312. • Q-NESTM between 1010 hrs and 1350 hrs on 23 January 2024 to manage the Nebo – Strathmore 275 kV No. 878 line outage. • Q-X_NQ_275_FDR3+BUS between 1020 hrs and 1350 hrs on 23 January 2024 to manage multiple outage conditions in northern and central Queensland (detailed below). • Q-SM_275BUS_CB between 1350 hrs on 23 January 2024 and 1405 hrs on 9 February 2024 to manage the outage of Strathmore 275 kV CB 8782. Constraint set Q-X_NQ_275_FDR3+BUS is a conservative set of equations used to manage multiple outage conditions in northern and central Queensland. AEMO correctly invoked this constraint set at 1020 hrs to manage the multiple outage condition that occurred with the initial contingency. Once all tripped equipment from the contingency event, except Strathmore 275 kV CB 8782, was returned to service, AEMO revoked the constraint set Q-X_NQ_275_FDR3+BUS at 1350 hrs. At the same time, there was an ongoing planned outage of Broadsound 275 kV CB 88312 in central Queensland. Therefore, both Strathmore 275 kV CB 8782 and Broadsound 275 kV CB 88312 were concurrently out of service until 1500 hrs, when Broadsound 275 kV CB 88312 returned to service. The constraint set Q-X_NQ_275_FDR3+BUS should not have been revoked at 1350 hrs as it was required to remain invoked until 1500 hrs to manage the multiple outage condition of these two CBs. Following the incident, AEMO and Powerlink reviewed whether the power system remained in a secure operating state during the period between 1350 hrs and 1500 hrs on the 23 January 2024 (when the constraint set Q-X_NQ_275_FDR3+BUS was not invoked). The review determined that the power system was in a secure operating state between 1350 hrs and 1500 hrs, as the constraint sets Q-BS_275BUS_CB and Q-SM_275BUS_CB adequately managed the concurrent outages of Broadsound 275kV CB 88312 and Strathmore 275kV CB 8782 under the prevailing system conditions during that period.

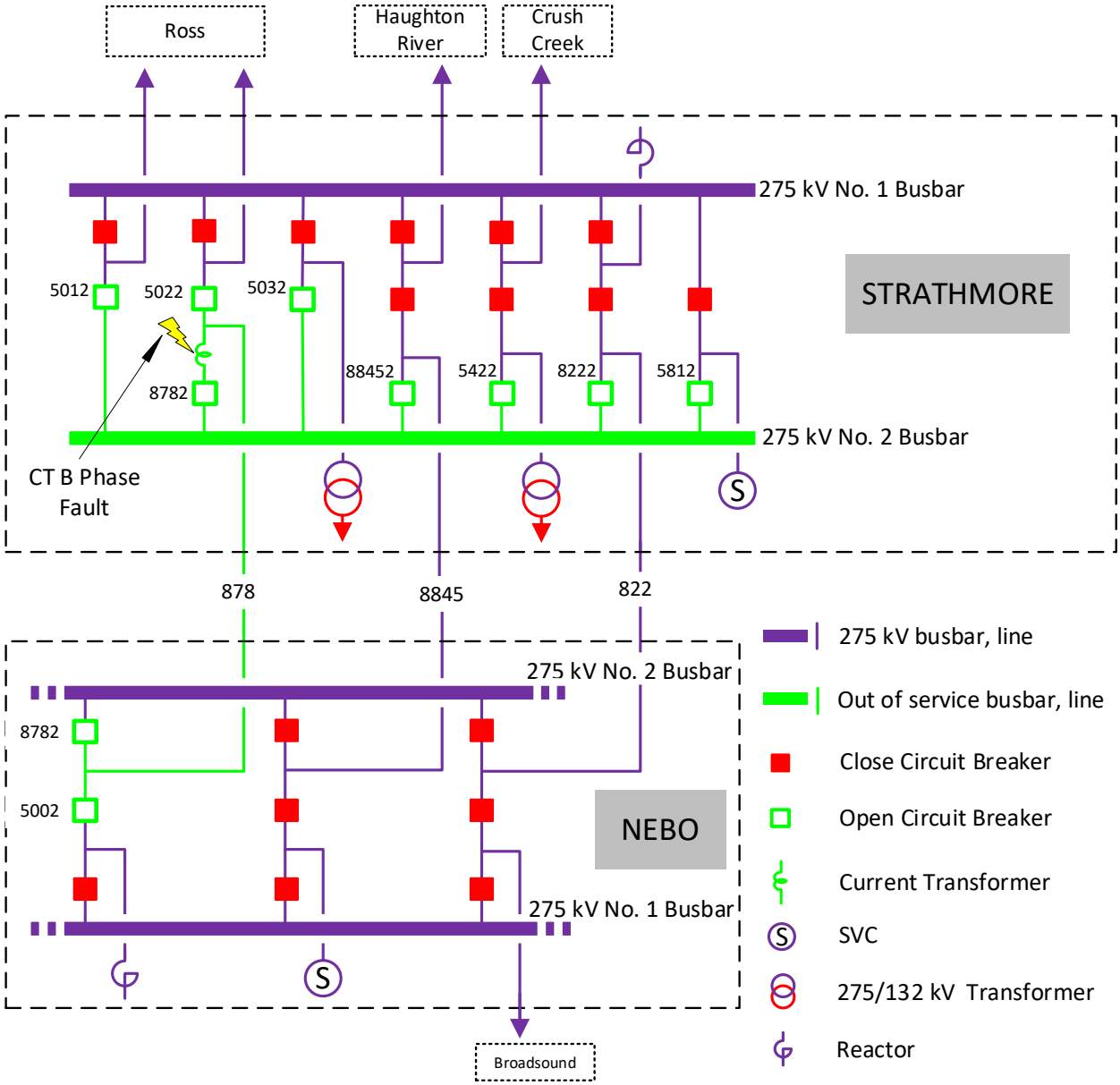
[6] See NER clause S5.1a.8.

[7] Frequency Operating Standard, effective 9 October 2023, available at https://www.aemc.gov.au/media/87484.

	Details
Reclassification	AEMO assessed whether to reclassify this incident as a credible contingency event[8]. On 23 January 2024, the cause of the incident was identified as an internal fault in the B phase 275 kV CT associated with Strathmore 275 kV CB 8782, and the Strathmore 275 kV CB 8782 was isolated. AEMO was satisfied that another occurrence of this event was unlikely under these conditions as the Strathmore 275 kV CB 8782, and its failed B phase 275 kV CT remained out of service. On 9 February 2024, Strathmore 275 kV CB 8782 was returned to service following replacement of the faulty 275 kV CT. As the faulty 275 kV CT had been replaced, there was no requirement to consider reclassifying the event. AEMO appropriately applied the reclassification criteria and determined the reclassification criteria were not met based on the information available to AEMO at the time. During the period where Strathmore 275 kV CB 8782 was out of service, the simultaneous trip of the Nebo – Strathmore 275 kV No. 878 line and Ross – Strathmore 275 kV No. 8857 line was considered a credible contingency based on the network configuration. AEMO has identified that the CT type which failed during this incident matches the CT type involved in the incident reported on 29 November 2023 at Braemar substation in Queensland and 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 the power system security. If AEMO identifies the need for reclassification of any event(s) during the process, AEMO will implement the required reclassification(s) and issue necessary market notices.
Market information	For this incident, AEMO issued the following market notices in accordance with NER requirements: • AEMO issued Market Notice 113659 at 1020 hrs on 23 January 2024 to advise the market of this non-credible contingency event. • AEMO issued Market Notice 113662 at 1131 hrs on 23 January 2024 to advise the market that the root cause of this non-credible contingency event had been identified and that it was unlikely to reoccur in the present conditions.
Conclusions	AEMO has concluded that: 1. At 0957 hrs on 23 January 2024, Strathmore 275 kV No. 2 busbar and Nebo – Strathmore 275 kV No. 878 line tripped due to an internal fault in the B phase 275 kV CT associated with Strathmore 275 kV CB 8782. The faulty 275 kV CT was replaced, and Strathmore 275 kV CB 8782 was returned to service on 9 February 2024. 2. The cause of the incident has been identified as transmission equipment failure – 275 kV CT internal fault. The root cause of the failed 275 kV CT internal fault is still under investigation by Powerlink. 3. The power system remained in a secure operating state throughout this incident and the FOS was met for this incident.
Recommendations	1. AEMO supports Powerlink's precautionary approach to increase the oil sampling frequency for this make and model 275kV CT, pending the results of the investigation into the root cause of the 275kV CT internal fault. 2. Powerlink to continue working to understand the root cause of the 275 kV CT's failure and to share key findings with AEMO and other TNSPs, as appropriate, by the end of August 2024. 3. AEMO to continue engaging closely with Powerlink and ElectraNet to assess possible risks to the power system security. 4. AEMO to consider updating the description of constraint set Q-X_NQ_275_FDR3+BUS to better clarify the applicable conditions for invoking it for AEMO's operators, by the end of August 2024.

[8] AEMO is required to assess whether or not to reclassify a non-credible contingency event as a credible contingency event – NER 4.2.3A(c) – and to report how the reclassification criteria were applied – NER 4.8.15(ca).

Figure 1 Post-incident diagram



Note: Strathmore 275 kV CB 5022 and Nebo 275 kV CB 5002 were in open status before the incident