
Trip of Broken Hill 220 kV Busbar on 15 February 2018

October 2018

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.

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INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1338 hrs on 15 February 2018
Region of incident	NSW
Affected regions	NSW
Event type	Operator error
Generation Impact	54 MW of generation lost
Customer load impact	45 MW of customer load lost
Associated reports	Nil

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1. Overview

This report relates to a reviewable operating incident¹ that occurred on 15 February 2018 in New South Wales. This incident involved the outage of the 220 kV busbar at Broken Hill.

There was a loss of 54 MW of generation and 45 MW of customer load as a result of this incident.

As this was a reviewable operating incident, AEMO is required to assess power system security over the course of this incident and 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 Broken Hill 220 kV busbar tripped as the result of incorrectly configured protection during the commissioning of the X6 line.
2. TransGrid has revised its commissioning processes to ensure this type of event does not reoccur.
3. AEMO was not required to reclassify this non-credible contingency as a credible contingency.
4. The power system remained in a secure operating state during 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 TransGrid³ and from AEMO's Energy Management Systems.

National Electricity Market Time (Australian Eastern Standard Time) is used in this report. Local time in New South Wales at the time of this incident is Market Time plus one hour.

2. The incident

At 1339 hrs on Thursday 15 February 2018, the 220 kV busbar at Broken Hill tripped, resulting in the loss of 54 MW of generation from the Broken Hill solar farm and the loss of 45 MW of customer load at Broken Hill.

The 220 kV busbar was returned to service at 1431 hrs on 15 February, and all load was restored by 1458 hrs on 15 February. Generation from Broken Hill solar farm was restored by 1500 hrs on the same day.

Refer to Appendix A2 for a detailed sequence of events.

As the trip of a busbar is not an expected event, this is a non-credible contingency and hence a reviewable operating incident. In accordance with clause 4.8.15 of the NER, AEMO is required to review and report on any reviewable operating incident.

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 TransGrid is transmission network service provider (TNSP) for the area in question.

3. TransGrid investigation

The following is based on information provided by TransGrid as transmission network service provider (TNSP) for the area in question.

As part of the commissioning works for the Silverton wind farm, circuit breaker (CB) X62 at Broken Hill was closed at 1041 hrs on 15 February 2018 to energise the Broken Hill – Silverton X6 220 kV transmission line (X6 line). At this stage CB 7412 at Silverton remained open.

At 1338 hrs on 15 February 2018, CB 7412 at Silverton was closed to energise the Silverton No. 1 transformer. Simultaneous with the closing of CB 7412 at Silverton, the 220 kV busbar protection at Broken Hill operated, resulting in the loss of the:

- X6 line.
- Broken Hill – Buronga X2 220 kV transmission line (X2 line).
- Broken Hill – Broken Hill Mines X4 220 kV transmission line (X4 line).
- Broken Hill No. 1 and No. 2 220/22 kV transformers.

The loss of the X2 line initiated the operation of the Broken Hill Auto Reclose Scheme⁴, resulting in the loss of the:

- Gas turbine 22 kV CB 2212.
- All 22 kV CBs supplying Essential Energy loads from Broken Hill.
- All in service 22 kV capacitor banks.

The Broken Hill solar farm also automatically shut down as designed via its anti-islanding protection after supply was lost to the 22 kV busbar at Broken Hill.

Approximately 10 seconds after supply was lost to the 22 kV busbar, the two static var compensators (SVCs) automatically shut down as designed.

Refer to Appendix A1 for network diagrams showing switchgear status before and immediately after the incident.

TransGrid investigated the incident and determined that the current transformer (CT) links for the X6 line input into the 220 kV busbar protection at Broken Hill were open and shorted. As such, any current flowing in the X6 line did not contribute to the busbar protection scheme, resulting in a summation imbalance. However, as the transformer at Silverton had not been energised when the X6 line was energised, the line charging current was not large enough to cause the busbar protection to operate. When the Silverton transformer was energised, the resulting in-rush current was sufficient to trigger the 220 kV busbar protection at Broken Hill.

The CT links had been left open and shorted as part of the installation process of the new CTs associated with the newly constructed X6 line at Broken Hill. The CT links should have been closed prior to energising the X6 line.

The CT links were closed and the X6 line returned to service at 1953 hrs on 20 February 2018.

As a result of this process failure, TransGrid initiated a review of commissioning processes and implemented a revised process to ensure that all circuits isolated as part of construction works are restored and signed off by a responsible officer prior to energising new equipment. This review was completed in April 2018.

⁴ The Auto Reclose Scheme initially trips CBs on the loss of voltage on the X2 line from Buronga. When the X2 line voltage is restored the Transformer (220 kV and 22 kV) CBs, X4 220 kV CB, and Essential Energy 22 kV CBs are automatically reclosed to restore supply.

4. Power system security

AEMO is responsible for power system security in the National Electricity Market (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.

This section assesses how AEMO managed power system security over the course of this incident.

The power system was in a secure operating state prior to this incident, and remained in a secure operating state during the incident. No specific action was required by AEMO to restore or maintain power system security during this incident.

AEMO correctly invoked constraint set N-BROKENH1_ZERO⁶ to ensure the Broken Hill solar farm did not receive a dispatch target while disconnected from the power system⁷.

4.1 Reclassification

At 1440 hrs on 15 February, shortly after the 220 kV busbar had been returned to service, TransGrid advised AEMO the cause of the incident had been determined to be associated with the X6 line.

As the X6 line had not been returned to service, the cause of the non-credible contingency had been removed, and therefore reclassification of this non-credible contingency as a credible contingency was not required.

5. 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 was required to inform the market on the following matters:

1. A non-credible contingency event - notify within two hours of the event⁹.
 - AEMO issued Market Notice 61290 at 1517 hrs – 99 minutes after the event.
2. Updates to the non-credible contingency event – as information becomes available¹⁰.
 - AEMO issued Market Notice 61384 at 1056 hrs on 19 February 2018.

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 Broken Hill solar farm upper limit = 0 MW. Note the Broken Hill gas turbines are non-scheduled generation and do not receive dispatch targets from AEMO.

⁷ Similar action was not required in relation to the Broken Hill GTs as these are not scheduled generating units.

⁸ AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see AEMO website at <http://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 10.3. Available 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.

¹⁰ AEMO is required to notify the Market as it becomes aware of new and material information – NER Clause 4.2.3A(d).

Over the course of this incident, AEMO issued appropriate, timely, and sufficiently detailed market information.

6. Conclusions

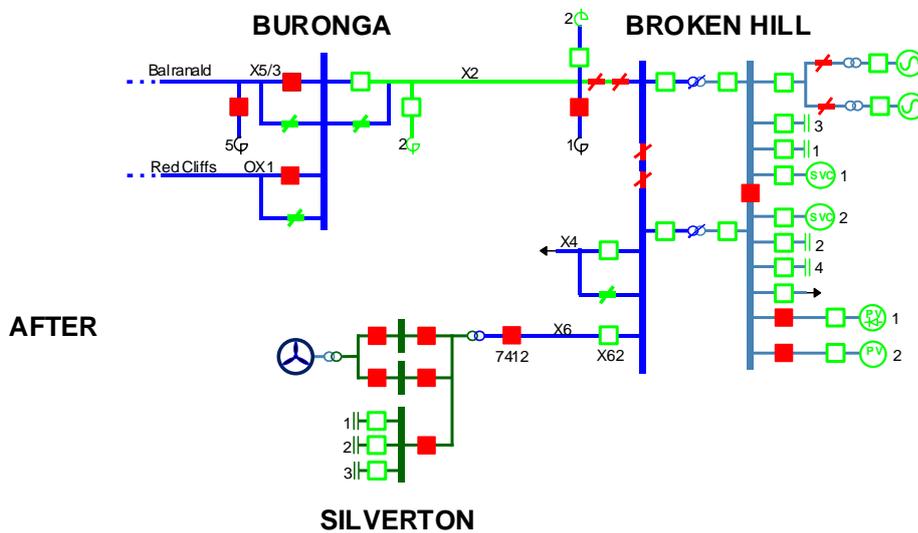
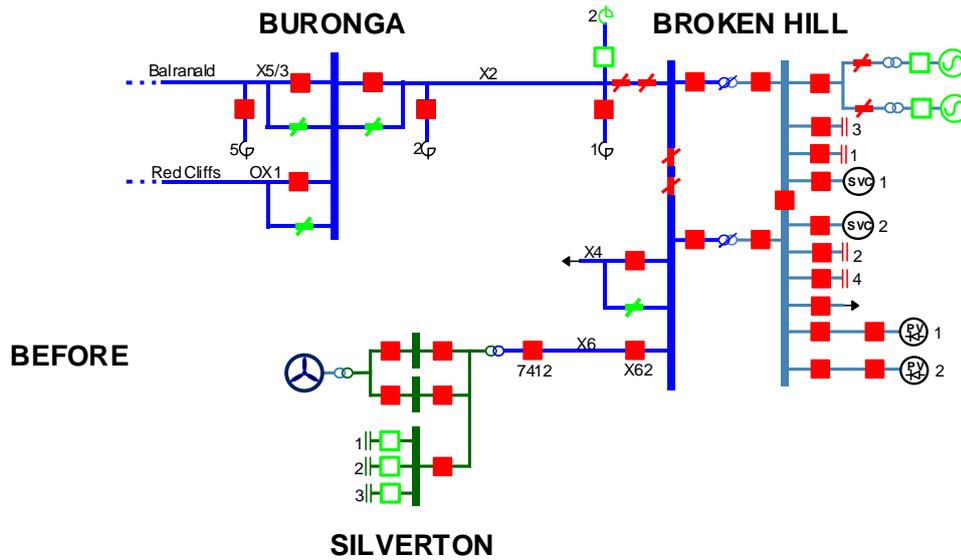
AEMO has assessed this incident in accordance with clause 4.8.15(b) of the NER. In particular, AEMO has assessed the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.

AEMO has concluded that:

1. The Broken Hill 220 kV busbar tripped as the result of incorrectly configured protection during the commissioning of the X6 line.
2. TransGrid has revised its commissioning processes to ensure this type of event does not reoccur.
3. AEMO was not required to reclassify this non-credible contingency as a credible contingency.
4. The power system remained in a secure operating state during this incident.

A1. Power system diagram

The diagrams below show the power system in the Broken Hill area before and immediately after this incident.



	220 kV Busbar, line		Transformer		Closed Isolator
	33 kV Busbar, line		Closed CB		Open Isolator
	22 kV Busbar, line		Open CB		Capacitor Bank
	Out of service Busbar, line		Reactor		

A2. Sequence of events

Date/time	Event
15/02/2018	
10:41 hrs	Silverton X6 line 220 kV CB X62 at Broken Hill closed by TransGrid operator.
13:38:54 hrs	Silverton No. 1 transformer 220 kV CB 7412 closed by TransGrid operator.
13:39:56 hrs	The following equipment at Broken Hill tripped: <ul style="list-style-type: none"> • X4 220 kV line (CB X42). • X6 220 kV line (CBX62). • No. 1 220/22 kV transformer (CBs 7412 & 2412). • No. 2 220/22 kV transformer (CBs 7422 & 2422). • 1-2 gas turbine 22 kV CB 2212. • No. 1 capacitor 22 kV CB 2712. • No. 2 capacitor 22 kV CB 2722. • No. 3 capacitor 22 kV CB 2732. • No. 4 capacitor 22 kV CB 2742. • All 22 kV load CBs.
13:38:58	X2 line 220 kV CB X22 at Buronga tripped.
13:39:07	The following equipment at Broken Hill tripped: <ul style="list-style-type: none"> • No. 1 SVC 22kV CB 2V12. • No. 2 SVC 22kV CB 2V22.
13:45	Constraint set N-BROKENH1-ZERO invoked.
14:31	X2 line 220 kV CB X22 at Buronga closed by TransGrid operator to restore supply to the Broken Hill 220 kV busbar.
14:37	Broken Hill No. 1 transformer returned to service to restore supply to the Broken Hill 22 kV busbar.
14:39	Broken Hill 22 kV load restored.
14:40	Broken Hill No. 2 transformer returned to service.
14:48	X4 220 kV line returned to service.
14:55	Constraint set N-BROKENH1-ZERO revoked.
14:57	Broken Hill solar plant No. 1 returned to service.
14:59	Broken Hill solar plant No2 returned to service.
15:17	Market Notice 61290 issued – advice of non-credible contingency.
19/02/2018	
10:56	Market Notice 61384 issued – cause of non-credible contingency identified and unlikely to recur.
20/02/2018	
19:53	X6 line returned to service.