



Failure of 275 kV Current Transformer at Brinkworth Substation on 16 October 2020

February 2021

Reviewable Operating Incident Report under the
National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of Incident	0610 hrs on 16 October 2020
Region of incident	South Australia
Affected regions	South Australia
Event type	Transmission equipment failure
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
CB	Circuit breaker
CT	Current transformer
kV	Kilovolt
ms	Millisecond
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.

DISCLAIMER

AEMO has made every reasonable effort 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.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this report:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this document; and
- are not liable (whether by reason of negligence or otherwise) for any statements or representations in this document, or any omissions from it, or for any use or reliance on the information in it.

COPYRIGHT

© 2021 Australian Energy Market Operator Limited. The material in this publication may be used in accordance with the copyright permissions on AEMO's website.

CONTACT

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

Contents

1.	Overview	5
2.	The incident	5
2.1	Pre-incident conditions	5
2.2	The incident	5
2.3	Analysis	6
3.	Power system security	7
3.1	Reclassification	7
4.	Market information	8
5.	Conclusions	8

Figures

Figure 1	Post fault configuration	6
----------	--------------------------	---

1. Overview

This report relates to a reviewable operating incident¹ that occurred on 16 October 2020 in South Australia. The incident involved the failure of a 275 kilovolt (kV) current transformer (CT) at Brinkworth resulting in the trip of the Brinkworth – Davenport 275 kV line, the Brinkworth – Templers West 275 kV line, and the Brinkworth 275/132 kV No. 3 Transformer.

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. This non-credible contingency was caused by the failure of a CT at Brinkworth. The failed CT was replaced and circuit breaker (CB) 6530 returned to service on 2 December 2020.
2. All protection systems operated as expected and as per design to clear the fault.
3. ElectraNet³ is continuing to work with the manufacturer of the CT to determine the cause of the failure.
4. AEMO correctly determined that reclassification of this non-credible contingency as a credible contingency event was not required.
5. 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 ElectraNet and AEMO.

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

2. The incident

2.1 Pre-incident conditions

Immediately prior to this incident, all transmission equipment in South Australia was in service except for the Mokota – Robertstown 275 kV line and the Robertstown No. 1 275/132 kV transformer, which were out of service for planned work.

2.2 The incident

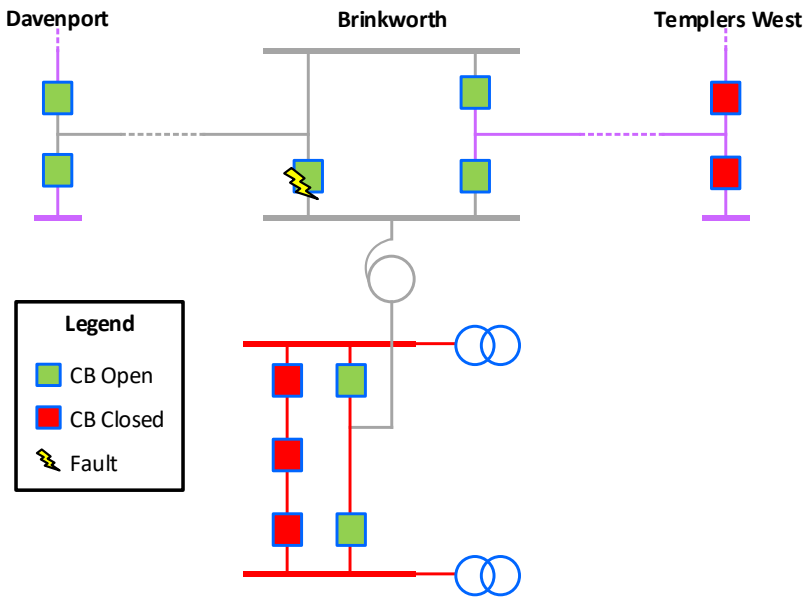
At approximately 0610 hrs on 16 October 2020, the Brinkworth – Davenport 275 kV line and the Brinkworth 275/132 kV No. 3 transformer tripped due to a high voltage fault on the power system. The Brinkworth – Templers West 275 kV line also tripped at the Brinkworth end only, leaving the Brinkworth east and west 275 kV busbars de-energised, as shown in Figure 1.

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 a Transmission Network Service Provider (TNSP) in South Australia.

Figure 1 Post fault configuration



The Brinkworth – Davenport and Brinkworth – Templers West 275 kV lines were restored to service at 1225 hrs on 16 October 2020, and the Brinkworth No. 3 275/132 kV transformer was returned to service at 1229 hrs on the same day. CB 6530 at Brinkworth was returned to service at 2 December 2020 after a failed CT had been replaced.

2.3 Analysis

The following is based on information provided by ElectraNet.

At 0610 hrs on 16 October 2020 a single phase to ground fault occurred at Brinkworth substation in the bay associated with the Davenport – Brinkworth 275 kV line. Protection systems correctly initiated a single phase trip of the line at both Brinkworth and Davenport. This did not clear the fault, because the fault was still supplied via the Brinkworth – Templers West 275 kV line and the No. 3 275/132 kV transformer at Brinkworth.

CB fail protection associated with CB 6530 at Brinkworth then operated to trip all three phases of the Davenport – Brinkworth 275 kV line, the No. 3 275/132 kV transformer at Brinkworth and the Brinkworth – Templers West 275 kV line at the Brinkworth end. The resulting power system configuration is shown in Figure 1. The total time to clear the fault was approximately 280 milliseconds (ms)..

Onsite inspection by ElectraNet revealed that the 'U' phase CT located on the busbar side of CB 6530 at Brinkworth had failed explosively. Given the location of the fault, protection systems operated correctly and as per design to clear the fault.

Clause S5.1a8(d) of the NER states that faults on the 275 kV network cleared by CB fail protection normally should be cleared within 250 ms. However, clause S5.1a8(f) of the NER states this only applies to facilities constructed or modified on or after the performance standards commencement date of 16 November 2003. As the Brinkworth substation was constructed in the late 1960s and Davenport in the mid 1980s, clause S5.1a8(d) of the NER does not apply, and ElectraNet has advised AEMO that the fault clearance time of 280 ms during this incident met the requirements as derived from the existing capability of each of the substations as at 16 November 2003, as per clause S5.1a8(g) of the NER.

ElectraNet isolated the failed CT and returned all equipment except CB 6530 to service by 1229 hrs on 16 October 2020.

The failed CT was later replaced, and CB 6530 was returned to service on 2 December 2020.

ElectraNet has a program of regular maintenance for CTs which includes checking of oil levels during quarterly substation maintenance checks and oil sampling every four years. The last oil level check was conducted on 9 July 2020 and the last oil sample on 26 February 2020. The CT had also recently undergone high voltage testing. All testing returned normal results.

ElectraNet has advised that investigation into the cause of the failure of the CT is ongoing with the manufacturer. However, at the time of publication of this report the CT has not been internally inspected. The failed CT was installed in 2006 and ElectraNet has approximately 320 similar CTs in service. Although a similar CT failed at Bungama in 2013, this was not from the same batch as the one at Brinkworth. While ElectraNet does not believe there is an increased risk of failure for this particular type of CT, ElectraNet has implemented revised procedures when working on or adjacent to this type of CT as a precautionary measure pending the outcome of the internal inspection of the CT.

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 NER⁴.

The power system was in a secure operating state prior to this incident and remained in a secure operating state for the duration of the incident.

AEMO invoked constraint set S-X_DVBR+BRTW⁵ at 0625 hrs on 16 October 2020, but revoked the constraint set at 0755 hrs on 16 October 2020. This was on advice from AEMO's constraint building team that the combination of this constraint set, and the constraint sets invoked as part of the planned concurrent outage of the Mokota – Robertstown 275 kV line may result in constraints binding and therefore impact the market unnecessarily. A constraint set designed to cover both the planned and unplanned outages was not available. AEMO continued to monitor the results of its contingency analysis tools to ensure the power system remained in a secure operating state.

3.1 Reclassification

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

Prior to any equipment being returned to service, ElectraNet had advised AEMO that the cause of the non-credible contingency had been identified and isolated and that a recurrence of the incident was unlikely. Based on this advice, AEMO correctly determined that reclassification of this incident as a credible contingency event was not required.

⁴ 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.

⁵ Out = Davenport-Brinkworth line and Brinkworth-Templers West line

⁶ AEMO is required to assess whether 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).

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 78888 at 0718 hrs on 16 October 2020, 68 minutes after the event, to advise of the non-credible contingency event.
2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical⁹.
 - AEMO issued Market Notice 78904 at 1320 hrs on 16 October 2020 to advise that the cause of the non-credible contingency had been determined and reclassification was not required.

For unplanned outages, AEMO is required to advise the market of variances to interconnector transfer limits as per section 19 of AEMO's Power System Security Guidelines. However, AEMO did not issue a Market Notice when constraint set S-X_DVBR+BRTW, which contains constraint equations with interconnector terms on the left hand side (LHS), was invoked. Constraint equations within this constraint set did not bind at any time and therefore had no impact on market outcomes.

While AEMO did not meet the requirements of Section 19 of the Power System Security Guidelines for this event, AEMO has formed a view that this type of market notice may no longer be required or provide value to participants, especially when the outage or constraint invocation is of short duration. AEMO, in consultation with market participants, will review the requirement to issue this type of Market Notice, particularly in regard to short term outages. In the meantime, operations staff have been reminded of the continuing requirement to issue a market notice as required by the 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. This non-credible contingency was caused by the failure of a CT at Brinkworth. The failed CT was replaced and CB 6530 returned to service on 2 December 2020.
2. All protection systems operated as expected and as per design to clear the fault.
3. ElectraNet is continuing to work with the manufacturer of the CT to determine the cause of the failure..

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 AEMO is required to notify the market of a reclassification – NER clause 4.2.3(g), details of the reclassification – 4.2.3(c), and when AEMO cancels the reclassification – 4.2.3(h).

4. AEMO correctly determined that reclassification of this non-credible contingency as a credible contingency event was not required
5. The power system remained in a secure operating state.

6. Recommendations

AEMO to, in consultation with market participants, review the requirements of Section 19 of the Power System Security Guidelines for short term outages that require invoking constraints with interconnector terms in their LHS. The expected completion date for this review is September 2021.