
Trip of the Wodonga Terminal Station No. 1 and No. 2 330 kV transformers on 23 November 2020

April 2021

Reviewable Operating Incident Report under the
National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of Incident	09:33 hrs on 23 November 2020
Region of incident	Victoria
Affected regions	Victoria
Event type	Protection control system mal-operation
Generation impact	No loss of generation
Customer load impact	52 MW lost at Wodonga Terminal Station
Associated reports	Trip of the Wodonga Terminal Station No. 1 and No. 2 330 kV transformers on 8 September 2020 ¹

ABBREVIATIONS

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CT	Current Transformer
DC	Direct current
NEM	National Electricity Market
NER	National Electricity Rules
REF	Restrictive earth fault
TNSP	Transmission Network Service Provider

¹ See https://www.aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2020/trip-of-no1-and-no-2-wodonga-330-kv-transformers.pdf?a=en

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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1. Overview

This report relates to a reviewable operating incident² that occurred on 23 November 2020 in Victoria. The incident involved the simultaneous trip of the No. 1 and No. 2 330/66/22 kilovolt (kV) transformers (No. 1 transformer and No. 2 transformer) at Wodonga Terminal Station (WOTS). The event resulted in the disconnection of the No. 1 and No. 2 330 kV busbars (No. 1 busbar and No. 2 busbar) at WOTS and disconnection of the Dederang – Wodonga (DDTS-WOTS) and Wodonga – Jindera (WOTS- Jindera) 330 kV lines.

There was no loss of generation as a result of this incident, however 52 megawatts (MW) of customer load was disconnected at WOTS. Supply from WOTS was restored at 10:35 hrs on 23 November 2020, approximately 62 minutes after the event.

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 security³.

AEMO has concluded that:

1. The No. 1 and No. 2 transformers tripped due to the unexpected operation of their respective transformer Y protection restrictive earth fault (REF) protection systems.
2. The transformer Y REF protection operated unexpectedly for an out of zone lightning strike in the WOTS 22 kV distribution network. The protection mal-operated due to an incorrect (overly sensitive) minimum operation setting.
3. AusNet Services⁴ has updated the transformer Y REF protection settings to reduce the likelihood of any future mal-operation. AusNet Services has completed a review of all protection settings that have been updated at WOTS.
4. The power system remained in a secure operating state throughout 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 AusNet Services 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

At the time of this incident all substation equipment at WOTS was in service.

² 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.

³ See NER clause 4.8.15(b).

⁴ AusNet Services is the relevant transmission network service provider (TNSP).

2.2 The incident

At 09:33 hrs on 23 November 2020, a lightning strike caused a fault on the WOTS 22 kV system. Coincident with this 22 kV fault, the WOTS No. 1 and No. 2 transformer protection operated unexpectedly, tripping both transformers and de-energising the WOTS No. 1 and No. 2 330 kV busbars. This also caused the disconnection of the DDTS-WOTS and WOTS-Jindera 330 kV lines, as there are no circuit breakers between the transformer HV windings and 330 kV busbars at Wodonga (see Appendix A1 for WOTS layout). Table 1 below summarises the sequence of events associated with this incident.

Table 1 Sequence of incident events (23 November 2020)

Time	Event
09:33	WOTS No. 1 and No. 2 transformer protection operates unexpectedly coincident with a lightning strike in the WOTS 22 kV network, resulting in de-energisation of the WOTS No. 1 and No. 2 330 kV busbars. This also disconnected the DDTS-WOTS and WOTS-Jindera 330 kV lines
09:52	WOTS No. 2 330 kV busbar, the DDTS-WOTS and WOTS-Jindera 330 kV lines were returned to service.
10:32	WOTS No. 1 330 kV busbar was returned to service.
10:35	WOTS No. 1 transformer returned to service, with Y protection system isolated.
10:54	WOTS No. 2 transformer returned to service with Y protection system isolated.
14:48	WOTS transformer No. 1 and No. 2 Y protection system restored with both transformers restricted earth fault protection systems isolated.

2.2.1 X and Y protection systems

Many elements of transmission equipment have two sets of primary protection systems to provide redundancy. Both these protection systems monitor the protected equipment and both systems will attempt to trip the equipment should a monitored (or in zone) fault occur. To differentiate between one primary protection system and another, AusNet Services refers to one system as the X protection and the other as the Y protection.

2.3 Analysis

The following is based on information provided by AusNet Services.

Coincident with a lightning strike on the WOTS 22 kV distribution network, the WOTS 330 kV No. 1 and No. 2 transformers tripped due to operation of their respective Y restrictive earth fault (REF) protection systems. The operation of these transformer REF protection was unexpected, and AusNet Services has determined it was due to the application of incorrect (overly sensitive) protection settings.

The lightning strike in the WOTS 22 kV network caused a high direct current (DC) component to flow through the WOTS transformer protection Current Transformers (CTs). This DC component exceeded the minimum operation setting of each transformer's Y REF protection, and caused them to both operate unexpectedly, tripping both WOTS transformers. The substation topology at WOTS meant that the tripping of the transformers disconnected the No. 1 and No. 2 busbars and the DDTS-WOTS and WOTS-Jindera lines (see Appendix A1). Both transformers' X REF protection systems have a higher minimum operation setting and did not operate.

The WOTS No. 2 busbar and the DDTS-WOTS and WOTS-Jindera 330 kV lines were returned to service approximately 19 minutes after the initial trip. The WOTS No. 1 transformer was returned to service approximately 62 minutes after the initial trip; reconnection of the WOTS No. 1 transformer also restored supply to the disconnected load at this time. The WOTS No. 2 transformer was returned to service

approximately 81 minutes after the initial trip. Both transformers were initially returned to service with their entire Y protection system isolated. At 14:48 hrs on 23 November 2020, each transformer's Y protection was restored, but with the REF protection element isolated.

On 24 November 2020, each transformer's Y protection minimum operation settings were increased to reduce the risk of re-occurrence. The Wodonga No. 1 and No. 2 transformer Y REF protection was then re-enabled on 24 November 2020.

There was a previous event on 20 September 2020 in which the WOTS No. 1 and No. 2 transformer X protection mal-operated causing both transformers to trip⁵. In that event, the X protection mal-operation was due to incorrect input signal configuration. After the previous incident, the incorrect X protection settings were updated, and AusNet Services commenced an audit of protection settings to ensure similar issues did not exist elsewhere. In response to this latest incident, AusNet Services has completed a review of all WOTS protection settings that have been updated as part of its replacement program. AusNet Services has also advised that the relay manufacturer will include a REF stability enhancement in its next firmware update. This enhancement will further improve relay stability during remote faults.

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 NER⁶. The power system remained in a secure operating state throughout this incident.

The WOTS No. 2 busbar and DDTs-WOTS and WOTS-Jindera 330 kV lines returned to service approximately 19 minutes after the initial trip. These assets returned to service before AEMO had finished implementing temporary constraints to re-secure the network. With the DDTs-WOTS and WOTS-Jindera 330 kV lines returned to service, temporary constraints were not implemented, as they were no longer required.

3.1 Reclassification

AEMO assessed whether to reclassify this incident as a credible contingency event⁷. Based on advice from AusNet Services that the cause of the incident had been identified and the faulty protection system isolated, AEMO correctly identified that reclassification of this incident as a credible contingency event was not required.

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 market⁸ over the course of this incident.

⁵ See https://www.aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2020/trip-of-no1-and-no-2-wodonga-330-kv-transformers.pdf?a=en

⁶ 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.

⁷ 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).

⁸ AEMO generally informs the market about operating incidents as they progress by issuing Market Notices – see <https://www.aemo.com.au/Market-Notices>.

For this incident, AEMO informed the market on the following matters:

1. A non-credible contingency event – notify within two hours of the event⁹.
 - AEMO issued Market Notice 80258 at 10:24 hrs on 23 November 2020, 51 minutes after the event, to advise of the non-credible contingency event.

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. The No. 1 and No. 2 transformers tripped due to the unexpected operation of their respective transformer Y protection REF protection systems.
2. The transformer Y REF protection operated unexpectedly for an out of zone lightning strike in the WOTS 22 kV distribution network. The protection mal-operated due to an incorrect (overly sensitive) minimum operation setting.
3. AusNet Services has updated the transformer Y REF protection settings to reduce the likelihood of any future mal-operation. AusNet Services has completed a review of all protection settings that have been updated at WOTS.
4. The power system remained in a secure operating state throughout this incident.

⁹ AEMO, Power System Security Guidelines, Section 7.3.

A1. WOTS diagram

The diagram below provides an overview of the Wodonga terminal station immediately prior to the incident.

Figure 1 Substation topology at WOTS

