
Trip of the Wodonga Terminal Station No. 1 and No. 2 330 kV transformers on 3 May 2021

September 2021

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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CONTACT

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

The NEM operates on Australian Eastern Standard Time (AEST). All times in this report are in AEST.

Abbreviations

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

Incident review

This reviewable operating incident¹ 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 AusNet Services (AusNet)² and from AEMO systems.

Table 1 Summary of event – the simultaneous trip of the No. 1 and No. 2 330/66/22 kV transformers at Wodonga Terminal Station

	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 on 3 May 2021 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) 330 kV line and Wodonga – Jindera (WOTS – Jindera) 330 kV line.
Incident classification	Protection/control system mal-operation.
Generation impact	Nil
Customer load impact	34 MW of load was lost at Wodonga Terminal Station.
Pre-incident conditions	At the time of this incident, all substation equipment at WOTS was in service.
Incident key events	<ol style="list-style-type: none"> At 0439 hrs: <ul style="list-style-type: none"> A lightning strike caused a fault on the WOTS 22 kV system. WOTS No. 1 and No. 2 330/66/22 kV transformer protection operated unexpectedly resulting in de-energisation of the WOTS No. 1 and No. 2 330 kV busbars. This also disconnected the DDTS – WOTS 330 kV line and the WOTS – Jindera 330 kV line. At 0450 hrs, WOTS No. 1 busbar, the DDTS – WOTS No.1 330 kV line and the No. 1 330/66/22 kV transformer were returned to service. At 0451 hrs, the WOTS – Jindera No.1 330 kV line was returned to service. At 0452 hrs, WOTS No. 2 busbar, the DDTS – WOTS No. 2 330 kV line, the WOTS – Jindera No. 2 330 kV line and No. 2 330/66/22 kV transformer were returned to service. At 0458 hrs, all disconnected load was restored. The No. 1 and No. 2 330/66/22 kV transformer Y protection Rapid Earth Fault Current Limiter (REFCL) remote trips were isolated on the same day.
Incident cause	Post-incident investigation determined that the WOTS No. 1 and No. 2 330/66/22 kV transformer Y protection unexpectedly operated for an out of zone lightning strike on the 22 kV system.

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 AusNet Services is the relevant asset owner in relation to this incident.

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.

	Details
Power system response (facilities and services)	<p>Coincident with the 22 kV fault caused by a lightning strike, the WOTS No. 1 and No. 2 transformer Y 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 330 kV line and the WOTS – Jindera 330 kV line, as there are no circuit breakers between the transformer HV windings and 330 kV busbars at Wodonga.</p> <p>The Y protection relays of No. 1 and No. 2 transformers at WOTS was triggered by REFCL remote trip signal immediately after the lightning strike on the WOTS 22 kV system at 0439 hrs.</p> <p>AusNet advised that the Wodonga Terminal Zone Substation REFCL was not in-service at the time of the incident and the REFCL did not record any trip initiate signals to the Y protection of both transformers. The protection mal-operation was likely due to the long distance low voltage secondary cables between the REFCL in the 22 kV yard and the transformer relays control building. It is likely that due to the low voltage secondary cable's length, the lightning strike induced sufficient current in these low voltage cables to trigger the Y protection. The WOTS Y protection relays interpreted this induced current as a trip signal from the REFCL and tripped.</p>
Rectification	<p>AusNet installed Active Burden Modules⁴ at the REFCL remote trip inputs of the Y protection relays of No. 1 and No. 2 transformer on 1 August 2021 to reduce risks associated with mal-operation of the protection relays during transients such as lightning.</p> <p>AusNet also advised that full review of all protection settings at WOTS had been completed following trip of the No. 1 and No. 2 330/66/22 kV transformers at WOTS on 23 November 2021 prior to this incident. This incident was not the result of incorrect protection relay settings. Therefore, no further review was necessary as an outcome of this event.</p>
Power system security	<p>The power system remained in a secure operating state throughout this incident.</p> <p>The DDTs – WOTS 330 kV line and WOTS – Jindera 330 kV line were returned to service approximately 13 minutes after the incident. With the DDTs – WOTS 330 kV line and WOTS – Jindera 330 kV line returned to service, temporary constraints were not implemented due to short frame for permission to restore at WOTS.</p>
Reclassification	<p>AEMO assessed whether to reclassify this incident as a credible contingency event⁵.</p> <p>At the time of the incident, AusNet could not determine the cause(s) of the incident, AEMO determined that the simultaneous trip of the No. 1 and No. 2 330/66/22 kV transformers was likely to reoccur and correctly reclassified the incident as a credible contingency from 0532 hrs on 3 May 2021. This reclassification was cancelled at 2055 hrs on the same day, after AusNet advised AEMO that the REFCL remote trip inputs of the Y protection relays of No. 1 and No. 2 transformer were isolated, and the non-credible contingency was unlikely to reoccur.</p>
Market information	<p>For this incident, AEMO issued the following market notices (all market notices for this incident were issued in accordance with NER requirements):</p> <ul style="list-style-type: none"> • AEMO issued Market Notice 85057 at 0530 hrs on 3 May 2021 advising of the non-credible contingency event. • AEMO issued Market Notice 85058 at 0532 hrs on 3 May 2021 reclassifying the event as a credible contingency. • AEMO issued Market Notice 85071 at 2055 hrs on 3 May 2021 cancelling the reclassification of this event.
Conclusions	<p>AEMO has concluded that:</p> <ol style="list-style-type: none"> 1. The No. 1 and No. 2 330/66/22 kV transformers tripped due to the unexpected operation of their respective transformer Y protection. 2. The Y protection relays of No. 1 and No. 2 330/66/22 kV transformers at WOTS operated by Rapid Earth Fault Current Limiter (REFCL) remote trip signal for an out of zone lightning strike in the WOTS 22 kV distribution network. 3. The protection mal-operation was likely due to the long distance low voltage secondary cables between the REFCL in the 22 kV yard and the transformer relays control building which resulted in sufficient induced current from the lightning strike to trigger the Y protection. 4. AusNet installed Active Burden Modules at the REFCL remote trip inputs of the Y protection relays of No. 1 and No. 2 transformer to reduce the likelihood of any future mal-operation due to transients and noise. 5. The power system remained in a secure operating state throughout this incident.

⁴ The Active Burden Module improves the functionality of digital relays by creating an immunity to noise and transients such as switching, lightning and etc.

⁵ 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).

	Details
Recommendations	AEMO as Victorian TNSP to consider historic events when reviewing the cost and benefit of augmentation the Declared Shared Network (DSN), considering events such as this in future assessments.

Figure 1 Substation topology at WOTS

