AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Trip and reclose of Mount Beauty to Dederang 220 kV Lines

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
DDTS	Dederang Terminal Station
hrs	Hours
kV	Kilovolt
MBTS	Mount Beauty Terminal Station
MW	Megawatts
NEM	National Electricity Market
NER	National Electricity Rules
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 AusNet Services (AusNet)[2] and from AEMO systems.

Table 1 Summary of event – Trip and reclose of both Dederang to Mount Beauty 220 kV lines

	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 29 March 2021 in Victoria. This incident involved the trip and auto-reclose of both Mount Beauty (MBTS) – Dederang (DDTS) 220 kilovolt (kV) transmission lines.
Incident classification	Protection/control system.
Generation impact	There was no loss of generation as a result of this incident.
Customer load impact	No customer load was tripped or automatically shed in response to this incident.
Pre-incident conditions	Prior to this incident, both MBTS – DDTS 220 kV transmission lines were in service.
Incident key events	1. At 2031 hrs (AEST) on 29 March 2021: – There was a white-phase to ground fault on the MBTS – DDTS 220 kV No.2 transmission line close to the DDTS end. – The MBTS – DDTS 220 kV No.2 transmission line tripped at both ends on 3-phases and successfully reclosed within 5 seconds. – The MBTS – DDTS 220 kV No.1 transmission line also tripped at both ends on 3-phases and successfully auto-reclosed within 5 seconds. 2. AEMO and AusNet noted that there was no lightning activity, adverse weather conditions or bushfires in the vicinity of the lines at the time. 3. AusNet confirmed to AEMO that the 3-phase trip of both lines was simultaneous, and the cause of the trip could not be confirmed at this time.
Incident cause	• AusNet confirmed that a patrol of the transmission lines was conducted on 30 March 2021 and no root cause for the single phase to ground fault could be identified. • AEMO and AusNet observed that there was no lightning activity, adverse weather conditions or bushfires in the vicinity of the lines at the time. • Subsequent investigation identified that the MBTS – DDTS 220 kV No. 2 line protection operated correctly to clear a fault, however the MBTS – DDTS 220 kV No. 1 transmission line tripped due to a malfunction of the Y

[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 transmission network service provider (TNSP) in Victoria.

[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
	protection[4] relay at the DDTS end. The distance protection function of this relay incorrectly detected a fault in the forward direction in Zone 1. This resulted in it initiating the tripping of the line circuit breaker at DDTS and sending a remote trip to the circuit breaker at the MBTS end. The breakers successfully auto-reclosed after being tripped.
Power system response (facilities and services)	Protection operation: • AusNet confirmed that the Y protection relays for the MBTS – DDTS 220 kV lines are Siemens 7SA522 relays which are approximately ten years old. • The relays comprise a parallel line compensation function, which is designed to compensate for the contribution of the parallel line to an earth fault on the protected line by adjusting the impedance loop equations used by the relay to include the earth current of the parallel line. Without compensation, the zero sequence impedance coupling of the parallel lines causes impedance/distance calculation errors. In most cases, without parallel line compensation, the ground current of the parallel line will cause the reach of the distance protection to be shortened. • Parallel line compensation is only applicable for faults on the protected line. For faults on the parallel line, the compensation causes a severe distance protection overreach which would lead to protection mal-operations. To guard against this the relay has an additional ground current balance setting which compares the measured ground current on the parallel line and the protected line. The MBTS – DDTS Y protection relays had a setting of ground current balance of 75 %, meaning the protected line ground current must be greater than 75 % of the parallel line ground current for the parallel line compensation function to be triggered. • For the fault at 2031 hrs on 29 March 2021, the fault on MBTS – DDTS 220 kV No.2 line caused a high residual earth current on the parallel No. 1 line. This resulted in the parallel line compensation of the No.1 line triggering, which caused incorrect scaling of the impedance and distance calculations in the DDTS Y protection relay. The relay incorrectly detected the fault in the forward direction in Zone 1, and therefore initiated tripping of the line.
Rectification	AusNet contacted the relay manufacturer following this incident and were advised that the most up-to-date firmware version 4.76 has a different calculation method for the residual earth fault current on parallel lines, which overcomes the issues associated with the parallel line compensation function. However, the hardware of the MBTS – DDTS Y protection relays are approximately ten years old, and do not support the latest firmware version. The manufacturer therefore recommended that the settings of the affected Y protection 7SA522 relays be modified to remove the parallel line compensation function to prevent reoccurrences of incorrect line tripping. AusNet provided confirmation to AEMO that the zone settings of the relays were reviewed following the removal of the parallel line compensation function, and it was determined that they are still appropriate. On 2 August 2021, AusNet advised AEMO that these settings changes to the MBTS – DDTS Y protection 7SA522 relays had been completed. AusNet has also advised that there are no other 7SA522 relays with the parallel line compensation function enabled in their network.
Power system security	The power system remained in a secure operating state throughout this incident and the Frequency Operating Standards[5] were met for this incident.
Reclassification	AEMO assessed whether to reclassify this incident as a credible contingency event[6]. At approximately 2110 hrs, given that no cause for the incident could be confirmed, AEMO correctly reclassified the simultaneous trip of both MBTS – DDTS 220 kV transmission lines as a credible contingency. AEMO assessed the potential security implications of the reclassification and did not identify any immediate system security issues. No constraint sets were available for the reclassification of the two MBTS – DDTS lines, however it was identified that the constraint sets for a single line outage of a MBTS – DDTS 220 kV line would effectively manage power system security until the constraint requirements could be reviewed and updated. As a result, the V-DDMB constraint set was invoked from 0615 hrs on 30 March 2021. At 1015 hrs on 30 March 2021, the newly created V-DDMB_N-2 constraint set was invoked in place of the V-DDMB constraint set. This set contains two thermal constraint equations that reduce Victorian generation to avoid the overloading of one of the Mt

[4] 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, ElectraNet refers to one system as the X protection and the other as the Y protection.

[5] Frequency Operating Standard, effective 1 January 2020, available at https://www.aemc.gov.au/media/87484.

[6] 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
	Beauty – Eildon 220 kV lines and the Eildon – Thomastown 220 kV line for the trip of both MBTS – DDTS 220 kV lines. Considering AusNet's findings, the reclassification remained in place until the settings of the MBTS – DDTS Y protection relays were updated in line with the manufacturer's recommendations and on-site testing was completed. Whilst the reclassification was in place, the associated constraint set (V-DDMB_N-2) remained invoked. AEMO also sought confirmation that the zone settings were reviewed following the removal of the parallel line compensation function. This confirmation was received from AusNet on 12 August 2021. The reclassification was cancelled, and the associated constraint set V-DDMB_N-2 was revoked at 1350 hrs on 13 August 2021.
Market information	For this incident, AEMO issued the following market notices (all market notices for this incident were issued in accordance with NER requirements): • AEMO issued Market Notice 83860 at 2113 hrs on 29 March 2021 to advise of the non-credible contingency event. The notice also advised of the reclassification of the simultaneous trip of the MBTS – DDTS 220 kV transmission lines as a credible contingency event. No constraints sets were invoked. • AEMO issued Market Notice 83865 at 0617 hrs on 30 March 2021, to advise that the constraint set V-DDMB was invoked from 0615 hrs until further notice. • AEMO issued Market Notice 83866 at 1016 hrs on 30 March 2021, to advise that the constraint set V-DDMB_N-2 was invoked from 1015 hrs until further notice. • AEMO issued Market Notice 89428 at 1354 hrs on 13 August 2021, to advise that the reclassification of the simultaneous trip of the MBTS – DDTS 220 kV transmission lines as a credible contingency event had been cancelled and the associated constraint set V-DDMB_N-2 had been revoked at 1350 hrs on 13 August 2021.
Conclusions	AEMO has concluded that: 1. There was a white-phase to ground fault on the MBTS – DDTS 220 kV No.2 transmission line, which caused it to trip and auto-reclose. Protection on this circuit operated correctly and as designed. The cause of the fault is unknown, but likely to be environmental. 2. The MBTS – DDTS 220 kV No.1 transmission line incorrectly tripped and correctly reclosed in response to the fault on the No. 2 line due to the parallel line compensation function being triggered in the DDTS Y protection relay.
Recommendations	AusNet updated the MBTS – DDTS Y protection relays to remove the parallel line compensation function. This followed a review by AusNet that determined that the removal of the parallel line compensation function would reduce the risk of both MBTS – DDTS lines tripping while maintaining adequate distance protection.