
Trip of the Farrell – John Butters and Farrell – Roseberry – Newton – Queenstown lines on 10 April 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

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

Abbreviations

Abbreviation	Term
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CB	Circuit Breaker
GPATS	Global Position and Tracking Systems
HV	High voltage
kA	Kiloamperes
kV	Kilovolt
LAZ	Lightning attachment zone
LWZ	Lightning warning zone
NEM	National Electricity Market
NER	National Electricity Rules
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 TasNetworks² and from AEMO systems.

Table 1 Summary of event: Trip of the Farrell – John Butters 220 kV line and Farrell – Roseberry – Newton – Queenstown 110 kV line

	Details
Reviewable operating incident type	Non-credible contingency event impacting critical transmission elements.
Incident details	This report relates to a reviewable operating incident that occurred on 10 April 2021 in Tasmania. The incident involved the simultaneous trip of the Farrell – John Butters 220 kilovolt (kV) transmission line (FA-JB line) and the Farrell – Roseberry – Newton – Queenstown 110 kV transmission line (FA-RB-NT-QT line).
Incident classification	Environmental – lightning
Generation impact	10 megawatts (MW) of generation was disconnected as a result of the incident.
Customer load impact	2 MW of customer load was disconnected as a result of the incident.
Incident cause	The trip of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line was likely caused by lightning strike.
Pre-incident conditions	<p>The John Butters power station is connected to the power system via the FA-JB 220 kV line and was generating 10 MW at the time of the event. Queenstown and Newton customer loads are connected to the power system via the FA-RB-NT-QT 110 kV line and was consuming 2 MW at the time of the event. Refer to Figure 1 for the geographic relationship between the FA-JB 220 kV line and the FA-RB-NT-QT 110 kV line.</p> <p>Earlier on 10 April 2021 there was lightning in the proximity of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line. As these lines are considered vulnerable to lightning³, AEMO reclassified the simultaneous trip of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line as a credible contingency. However, the reclassification was cancelled prior to this incident as no lightning strikes had been recorded in the Lightning Warning Zone (LWZ) or the Lightning Attachment Zone (LAZ)⁴ for 30 minutes.</p>

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 TasNetworks is a Transmission Network Service Provider (TNSP) in Tasmania.

³ Refer to AEMOs Power System Security Guidelines (SO_OP_37150) section 8.4, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3715-power-system-security-guidelines.pdf?la=en.

⁴ Refer to AEMOs Power System Security Guidelines (SO_OP_37150) section 8.4.3 for details of the Lightning Detection Zones, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3715-power-system-security-guidelines.pdf?la=en.

	Details
Key events	<ol style="list-style-type: none"> 1. At 1133 hrs on 10 April 2021, the FA-JB 220kV line and FA-RB-NT-QT 110 kV line tripped simultaneously. Based on subsequent review of protection logs, it was identified that the FA-JB 220 kV line tripped due to a two-phase to ground fault and the FA-RB-NT-QT 110 kV line tripped due to a three-phase fault. Tripping of the FA-JB 220 kV and the FA-RB-NT-QT 110 kV line resulted in the disconnection of the John Butters power station and 2 MW of customer load at Queenstown and Newton Substations. 2. The FA-RB-NT-QT 110 kV line successfully auto-reclosed within 11 seconds of the fault. 3. The FA-JB 220 kV line does not have auto reclose installed and was restored to service manually by TasNetworks operators three minutes later at 1136 hrs on 10 April 2020. 4. John Butters power station returned to service at 1138 hrs on 10 April 2021. 5. All load was restored by 1358 hrs.
Power system response (facilities and services)	<p>Prior to the incident, there was lightning activity in the area of these transmission lines, however, no lightning strikes had been recorded in LWZ or LAZ in 30 minutes prior to the faults occurring.</p> <p>Post incident investigation has confirmed:</p> <ul style="list-style-type: none"> • The protection systems on the FA-JB 220 kV line and the FA-RB-NT-QT 110 kV line operated correctly to isolate the faulted lines. • There were two lightning strikes near the lines at the time of incident. The lightning strikes had an approximate magnitude of 18.8 kiloamperes (kA) and 58.4 kA respectively. The simultaneous trip of the FA-JB 220 kV line and the FA-RB-NT-QT 110 kV line was likely caused by the high magnitude lightning strike. • Protection systems at Farrell indicated that the faults were approximately located at 38 km to 41 km south of the Farrell substation which is in the region of Towers 98 and 108 of the FA-JB 220 kV line. At the same time of incident, Global Position and Tracking Systems (GPATS) recorded the high magnitude lightning strike of 58.4 kA which was several kilometres from west of Queenstown substation and near to the faults recorded by protection systems at Farrell. Refer to Figure 2 for the lightning data recorded by GPATS. The FA-RB-NT-QT 110 kV line and the FA-JB 220 kV line share common towers⁵ located in mountainous terrain approximately 460 metres above sea level and are protected by an overhead earth wire in this area. • A ground patrol of the lines in the fault area has been completed by TasNetworks, with no obvious signs of damage which may have caused (or be the result of) the incident.
Associated reports	<p>There were previous incidents on 28 May 2019 and 21 August 2019 in which the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line tripped due to lightning⁶. At the time of the incident report in 2019, it was concluded that:</p> <ul style="list-style-type: none"> • The FA-JB 220 kV and FA-RB-NT-QT 110 kV line are considered as vulnerable to lightning, so, the simultaneous trip of these lines is considered as a credible incident⁷ during periods of lightning activity. • There are towers associated with these circuits known to have poor (high) footing resistance. As a result, these towers are at greater risk of experiencing back flashover⁸ when struck by lightning. Due to this information, it was concluded that there is an increased probability of a three-phase fault occurring on the FA-RB-NT-QT 110 kV line during periods of lightning activity. As a result, AEMO amended its reclassification process and considers a three-phase fault on the FA-RB-NT-QT 110 kV line as a credible contingency⁹ during periods of lightning activity as determined in accordance with its Power System Security Guidelines.

⁵ Tower 18 through Tower 103 of the FA-JB 220 kV line

⁶ Refer to the incident report Trip of the Farrell – John Butters and Farrell – Roseberry – Newton – Queenstown lines on 28 May and 21 August 2019, at https://www.aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2019/report-trip-of-fa-jb-and-fa-rb-nt-qt-lines.pdf?la=en&hash=0E580D2504D16A29E5CBB71E7076074.

⁷ In accordance with the process specified in section 8.4 of SO_OP_3715 Power System Security Guidelines.

⁸ Back flashovers generally occur in transmission lines during lightning strikes when the potential of the tower rises in relation to the conductor. This causes the voltage across the insulators to increase beyond the withstand limits, resulting in a flashover. Lightning strikes can discharge thousands of amperes of current in very short time. This high current needs to be discharged quickly into the earth to prevent the potential of the tower from rising. Back flashover occurs when the lightning which has struck the tower is unable to discharge to the earth. This can occur when transmission towers have a high footing resistance.

⁹ Under clause 4.2.3(e) of the NER, a three-phase fault is normally considered as a non-credible contingency.

	Details
Rectification and/or preventative procedure	After the incidents on 28 May 2019 and 21 August 2019, TasNetworks carried out remedial works by installing a grounding system composed of counterpoise conductors on some high risk towers to improve the lightning resilience of the transmission line. However, due to local access and geographical limitations the installed counterpoise conductors could not be optimally placed. The resultant close proximity of counterpoise conductors led to a smaller area for fault current dissipation, meaning the high risk towers still have footing resistance in excess of 20 ohms. As a result, the lines are still susceptible to flashover for high magnitude strikes.
Power system security	The power system remained in a secure operating state throughout this incident.
Reclassification	<p>AEMO assessed whether to reclassify this incident as a credible contingency event¹⁰.</p> <p>Prior to the incident on 10 April 2021, there was lightning activity in the vicinity of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line. As the lines are considered as vulnerable to lightning, the simultaneous trip of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line had been reclassified as a credible contingency from 0902 hrs on the same day¹¹. This reclassification was cancelled¹² at 1004 hrs in line with AEMO's procedures as no lightning strikes had been recorded in the LAW or LAZ for 30 minutes. Therefore, AEMO was not required to reclassify the simultaneous loss of both lines as a credible contingency event prior to the incident.</p> <p>Immediately after the incident at 1133 hrs on 10 April 2021, AEMO's Lightning Reclassification Tool identified lightning in the area. Consequently, AEMO reclassified the simultaneous loss of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line as a credible contingency event from 1139 hrs on the same day. No constraint sets were required to be invoked as a result of this reclassification.</p> <p>The reclassification was cancelled at 1744 hrs on 10 April 2021 as there was no longer any lightning activity in the area.</p>
Market information	<p>For this incident, AEMO issued the following market notices¹³ (all market notices for this incident were issued in accordance with NER requirements):</p> <ul style="list-style-type: none"> • AEMO issued Market Notice 84080 at 1139 hrs on 10 April 2021 - Advice of reclassifying the event as a credible contingency event. • AEMO issued Market Notice 84081 at 1153 hrs on 10 April 2021 – Advice of non-credible contingency event. • AEMO issued Market Notice 84086 at 1744 hrs on 10 April 2021 – Advice of cancellation of the reclassification of the non-credible contingency event.
Conclusions	<p>AEMO has concluded that:</p> <ol style="list-style-type: none"> 1. The trip of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line was likely caused by lightning. 2. All protection operated correctly to clear the faults. 3. AEMO correctly reclassified the simultaneous trip of the FA-JB 220 kV line and FA-RB-NT-QT 110 kV line as a credible contingency after the incident. 4. The power system remained in a secure operating state throughout this incident.
Recommendations	<p>Two actions are recommended as outcomes of the incident:</p> <ul style="list-style-type: none"> • TasNetworks to notify AEMO if it is believed that there is an increased risk of equipment tripping due to high footing resistance during abnormal conditions¹⁴ in accordance with Clause 4.2.3. Classification as an abnormal condition allows AEMO to take additional measures to manage power system security if required. • TasNetworks to review the earthing system at towers with high footing resistance and undertake further remediation.

¹⁰ 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).

¹¹ Market Notice 84078.

¹² Market Notice 84079.

¹³ See <https://aemo.com.au/en/market-notice>

¹⁴ Storm in the area of towers with very high footing resistance regardless if there is any lightning detected in LWZ and/or LAZ of those lines.

Figure 1 The geographic relationship between the FA-JB 220 kV line (in blue) and the FA-RB-NT-QT 110 kV line (in red)

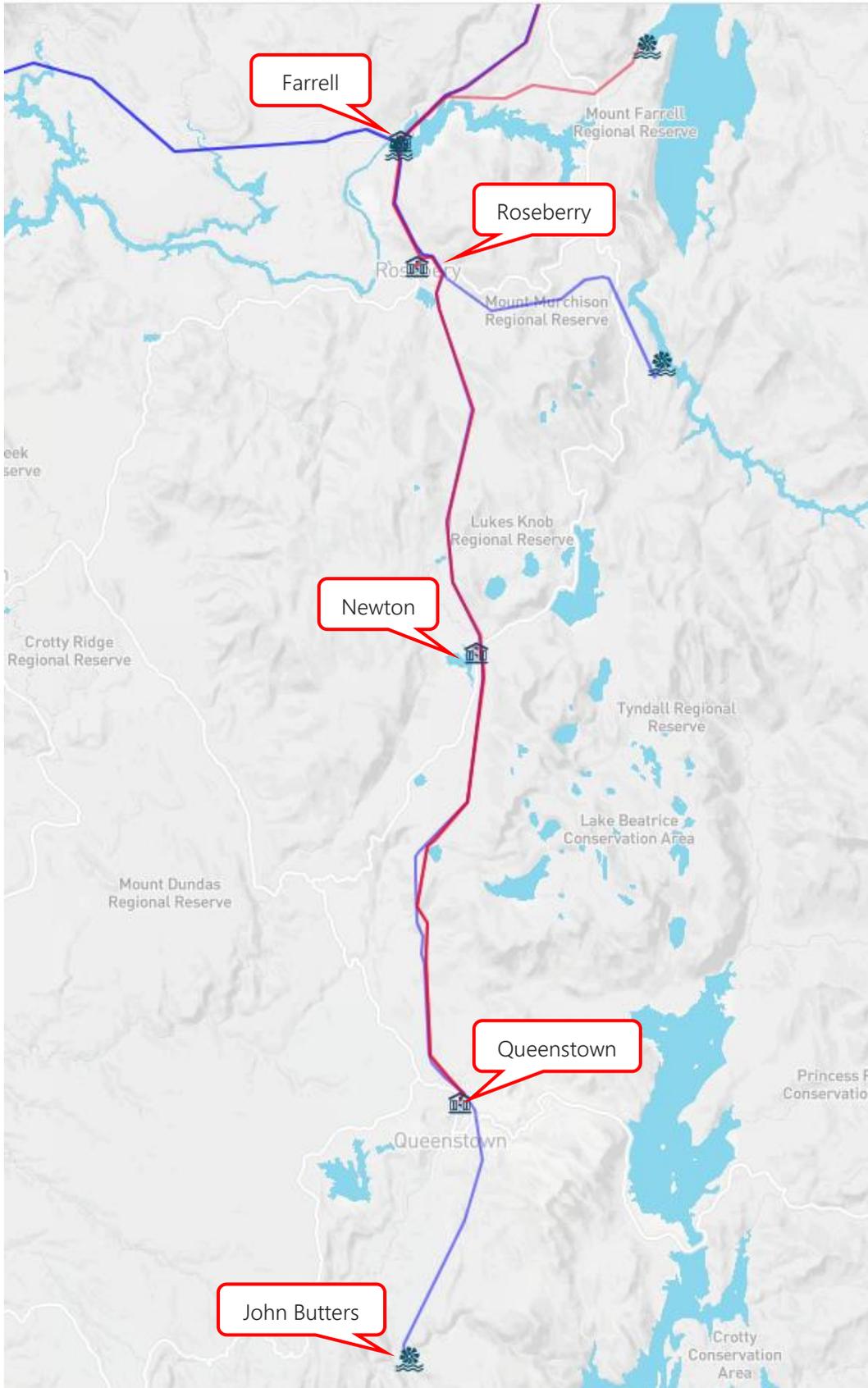


Figure 2 GPATS lightning data near to Queenstown substation and Tower 108 (time is in Coordinated Universal Time (UTC))

