AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Trip of Farrell to Reece No. 1 and No. 2 220 kV Transmission Lines in Tasmania on 6 November 2019

June 2020

Reviewable Operating Incident Report under the National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of Incident	18:52 hours on 6 November 2019
Region of incident	Tasmania
Affected regions	Tasmania
Event type	Protection operation due to lightning
Generation impact	111 MW of generation was disconnected as a result of this incident.
Customer load impact	No customer load was disconnected as a result of this incident.
Associated reports	Nil

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CB	Circuit breaker
kV	Kilovolt
NEM	National Electricity Market
NER	National Electricity Rules
OOS	Out of Service
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.

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1. Overview

This report relates to a reviewable operating incident[1] that occurred on 6 November 2019 in western Tasmania. The incident involved the simultaneous trip of both circuits of the double circuit Farrell–Reece–Pieman 220 kilovolt (kV) transmission line[2].

The incident resulted in the disconnection of 111 megawatts (MW) of generation at Reece Power Station, with no customer load being disconnected as a result of this incident.

As this is 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 security[3].

AEMO has concluded that:

1. It is likely that the simultaneous trip of the Farrell–Reece–Pieman 220 kV transmission line No. 1 and No. 2 circuits was caused by lightning.
2. The transmission line protection systems operated successfully as designed, clearing the resulting blue phase-to-ground faults on each line circuit within 80 milliseconds (ms), which is compliant with the maximum total fault clearance times required by the National Electricity Rules (NER)[4].
3. The possibility of a double circuit trip was correctly reclassified as a credible contingency event following the incident.
4. The power system remained in a secure operating state following the double circuit trip event.

This report is prepared in accordance with clause 4.8.15(c) of the NER. It is based on information provided by TasNetworks, Hydro Tasmania and AEMO[5].

National Electricity Market (NEM) time (Australian Eastern Standard Time [AEST]) is used in this report unless otherwise stated. Local time in Tasmania at the time of this incident was AEST plus one hour.

2. The incident

2.1 Pre-incident conditions

Figure 1 shows the route in Tasmania of the double circuit Farrell–Reece–Pieman 220 kV transmission line.

Figure 2 shows the switching configuration and status of the circuit breakers (CBs) for the No. 1 and No. 2 transmission line circuits immediately prior to the trip event.

[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] The issued Market Notices associated with this incident refer to the line circuits as the Farrell–Reece No. 1 and No. 2 220 kV transmission lines. This double circuit line was recently extended to the newly constructed Pieman 220 kV Substation, as required for connection of the Granville Harbour wind farm to the transmission network. The Pieman Substation was not fully commissioned at the time of the incident.

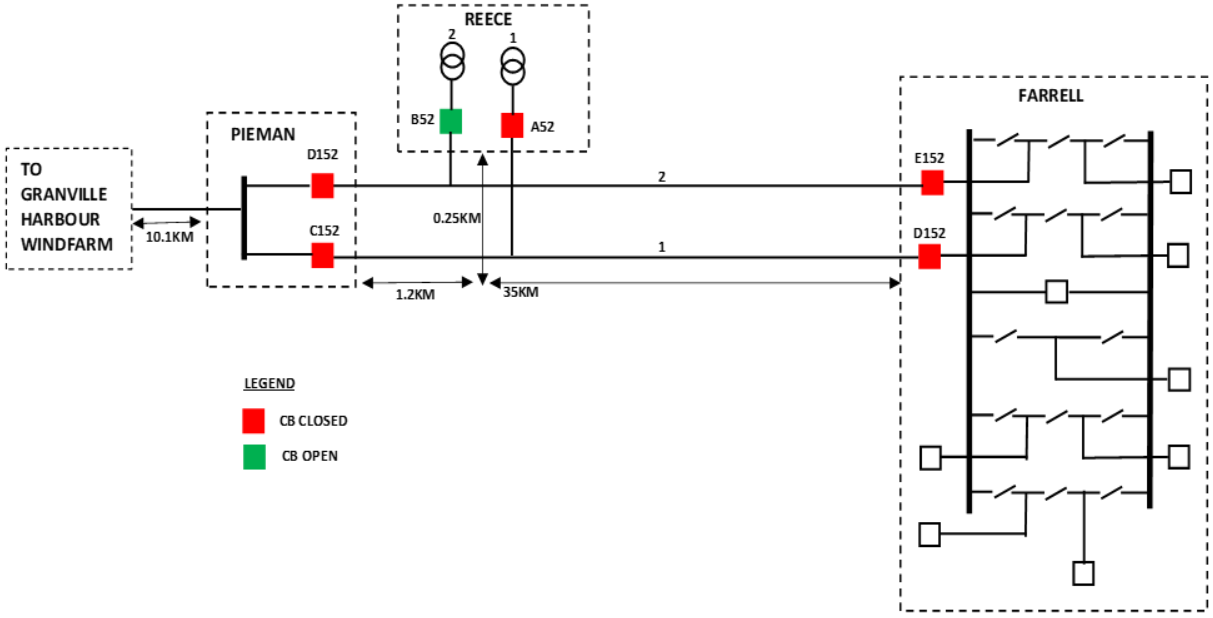
[3] See NER clause 4.8.15(b).

[4] See NER clause S5.1a.8.

[5] TasNetworks is the Transmission Network Service Provider (TNSP) for Tasmania. Hydro Tasmania is the operator of the Reece Power Station.

Figure 1 Farrell–Reece–Pieman 220 kV transmission line route in western Tasmania

Figure 2 Pre-trip Farrell–Reece–Pieman 220 kV transmission No. 1 and No. 2 circuits



Immediately prior to the incident, all major transmission equipment elements – such as busbars and transmission lines – were in service, except for the following:

- Reece Power Station No. 2 generating unit was out of service, with the 220 kV line CB B52 open.
- Auto-reclose functions on the No. 1 and No. 2 Farrell–Reece–Pieman 220 kV transmission line circuits at Farrell and Pieman were disabled, for commissioning activities on the Pieman switching station protection systems. It is noted that there is no auto-reclose on the Hydro Tasmania 220 kV CBs.
- The 220 kV Bus at Pieman switching station was energised only (with CBs C152 and D152 closed), and the Granville Harbour wind farm was not commissioned.

Reece Power Station No. 1 generating unit was in service generating 111 MW.

Prior to the incident, the loss of both Farrell–Reece–Pieman 220 kV line circuits had been reclassified as a credible contingency event due to lightning, in accordance with AEMO's Power System Security Guidelines. This reclassification was in place from 16:38 hrs to 17:22 hrs on 6 November 2019. There was no reclassification in place at the time of the incident as the lightning had moved away from the lines.

2.2 The incident

2.2.1 Sequence of events

The sequence of events between the 18:52 hours (AEST) power system event and return to service of the Farrell–Reece–Pieman No. 1 and No. 2 220 kV transmission line circuits is summarised in Table 1.

Table 1 Sequence of events on 6 November 2019

Time	Events
18:52:02	A -90.7 kA lightning strike was recorded by the GPATS lightning tracking system, approximately 4.5 km from the Reece substation and 30 km west of Farrell Substation (see Figure 3 and Figure 4).
18:52:02	Blue phase-to-earth faults occurred on both Farrell–Reece–Pieman 220 kV Transmission line circuits resulting in the operation of the line protection schemes at all three substations, tripping CBs Farrell D152 & E152, Reece A52, and Pieman C152 & D152 (shown in Figure 4Error! Reference source not found.).
	Reece unit 1 tripped, with output reduced from 111 MW to 0 MW.
18:53:52	The Farrell–Reece–Pieman No. 1 220 kV line circuit was returned to service by manual closure of the Farrell D152 CB (by TasNetworks Operations).
18:54:43	The Farrell–Reece–Pieman No. 2 220 kV line circuit was returned to service by manual closure of the Farrell E152 CB (by TasNetworks Operations).
18:55:05	Supply to the Pieman Switching Station was re-established from the Farrell–Reece–Pieman No. 1 220 kV line circuit by manual closure of the Pieman C152 CB (by TasNetworks Operations).
18:55:16	The second supply to Pieman Switching Station from the Farrell–Reece–Pieman No. 2 220 kV line circuit was re-established by manual closure of the Pieman D152 CB (by TasNetworks Operations).
19:16:37	Reece Power Station was reconnected to the 220 kV transmission system by manual closure of the Reece A52 CB (by Hydro Tasmania Generation Operations).

2.3 Analysis

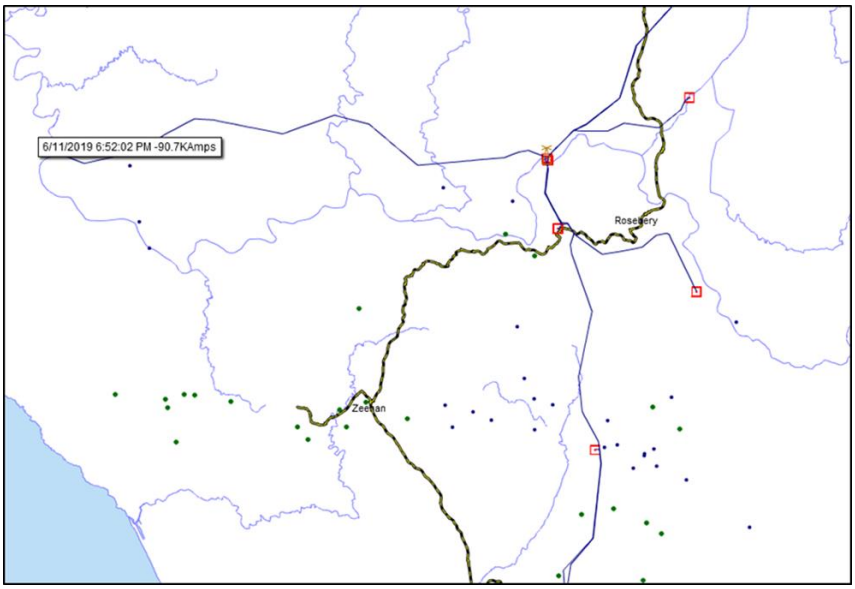
The following is based on information provided by TasNetworks and Hydro Tasmania.

During 6 November 2019, a number of lightning strikes were recorded in the mountainous west coast of Tasmania region.

One high magnitude (-90.7 kA[6]) lightning strike was recorded in the Farrell–Reece–Pieman 220 kV transmission line corridor (as shown by Figure 3 Error! Reference source not found.).

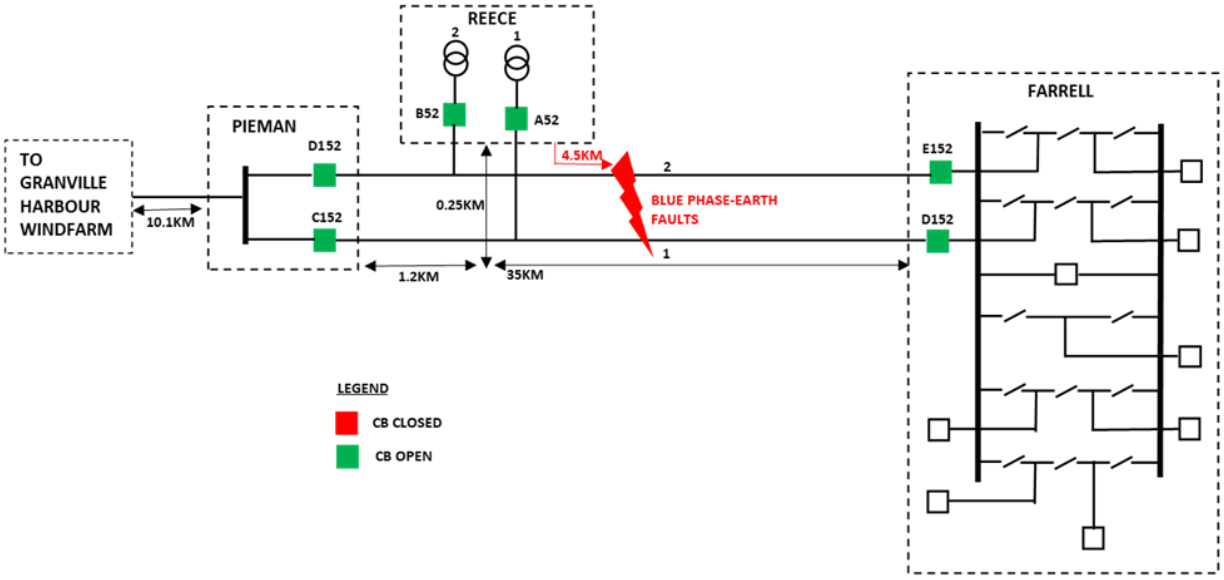
[6] As recorded by GPATS the lightning tracking system used by TasNetworks and AEMO.

Figure 3 GPATS lightning data near the Farrell–Reece–Pieman 220 kV double circuit line



TasNetworks identified this as the likely cause of the simultaneous faults on both circuits, with the possibility of a direct hit on one circuit and flashover on the adjacent circuit. The distance to fault readings indicate that the faults occurred approximately 4.5 km east of Reece Dam Substation (see Figure 3), within the area between towers T76 and T80. There is an overhead earth wire installed between these towers. Figure 4 shows the status of the relevant part of the power system immediately after the faults.

Figure 4 Post fault status of the Farrell–Reece–Pieman 220 kV transmission line circuits

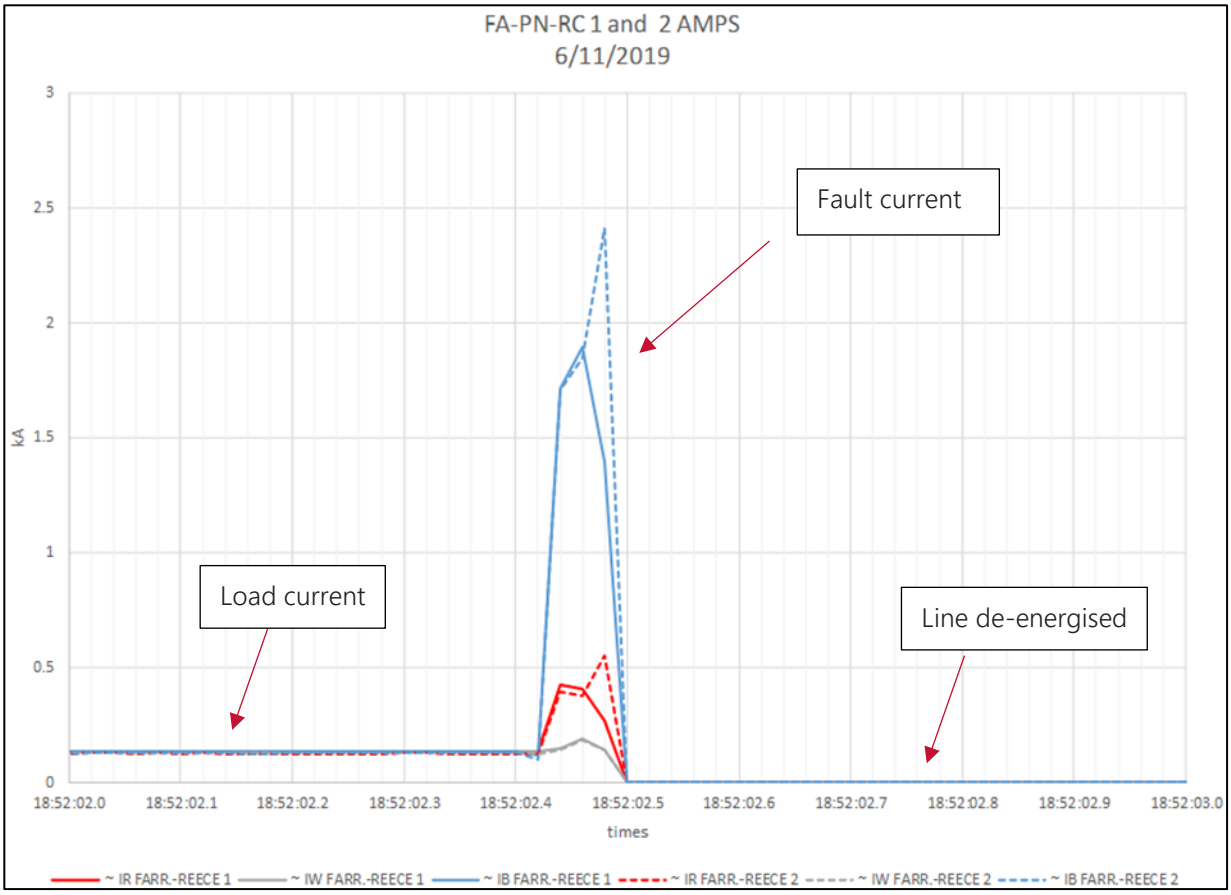


The auto-reclose functions on both transmission line circuits at Farrell and Pieman were not operational, due to ongoing commissioning activities being undertaken at the new Pieman switching station. Auto-reclose is not installed on power station generator CBs, so manual closure of all CBs was required to re-establish 220 kV supply to the Pieman and Reece Dam substations from Farrell substation.

As shown by the TasNetworks fault data in Figure 5, simultaneous blue phase-to-ground faults occurred on both circuits of the Farrell–Reece–Pieman 200 kV transmission line, and the line protection systems

successfully cleared the faults within 80 ms from fault inception. This meets the total fault clearance times required by the NER[7] (maximum times of 120 ms near end and 220 ms remote end).

Figure 5 TasNetworks Farrell–Reece–Pieman 220 kV transmission line fault data



2.4 Footing resistance

One of the factors impacting the susceptibility of a transmission line to lighting strikes is the tower footing resistance, that is the resistance between the metal parts of the tower and the ground. If the footing resistance is too high the benefits offered by the tower earth wires is significantly reduced. In August 2019 TasNetworks upgraded the earthing on several transmission towers on the Farrell – Reece – Pieman lines in the area normally impacted by lightning as shown in Table 2.

Table 2 Changes in tower resistance

Tower	Pre upgrade resistance (Ω)	Post upgrade resistance (Ω)	% change
T60	33	8.1	75%
T61	9	5.5	39%
T70	28	7.9	72%

[7] See NER clause S5.1a.8.

These changes have increased the withstand capability of these towers leading to a lower likelihood of a back-flashover events caused by lightning. However, if the lightning strike is large enough back-flashovers are still possible. The lightning strike in this incident was a high magnitude strike.

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 NER[8].

The power system was in a secure operating state prior to this incident.

After both circuits of the Farrell–Reece–Pieman 200kV transmission line were returned to service, AEMO reclassified the simultaneous loss of both line circuits as a credible contingency (see Section 3.1) and invoked constraint set F-T-FARE N-2[9] to maintain the power system in a secure operating state. Constraint equations contained in this constraint set did not bind therefore they had no impact on market outcomes.

3.1 Reclassifications

After the Farrell–Reece–Pieman transmission line circuits had been returned to service, AEMO assessed whether to reclassify this incident as a credible contingency event[10].

As there was still lightning activity in the vicinity of the lines, AEMO correctly determined, in accordance with AEMO's Power System Security Guidelines, that reclassification of the simultaneous loss of both Farrell–Reece–Pieman line circuits as a credible contingency was required.

This reclassification was made at 18:56 hrs on 6 November 2019 and was cancelled at 20:59 hrs on 6 November 2109 after the lightning activity had moved away from the lines.

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 market[11] 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 event[12].
   - AEMO issued Market Notice 70979 at 19:24 hours on 6 November 2019, 32 minutes after the event, to advise of the non-credible contingency event.

[8] 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.

[9] Loss of both Farrell–Reece lines declared credible, impacts Frequency Control Ancillary Service (FCAS) requirements.

[10] 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).

[11] AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see https://www.aemo.com.au/Market-Notices

[12] 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.

2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical[13].
   - AEMO issued Market Notice 70975 at 18:56 hours on 6 November 2019, four minutes after the event and one minute after both Farrell–Reece–Pieman 220 kV line circuits were returned to service, reclassifying the simultaneous loss of both line circuits as a credible contingency.
   - AEMO issued Market Notice 70982 at 20:59 hours on 6 November 2019, two hours later, cancelling the reclassification.

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. It is likely that the simultaneous trip of the Farrell–Reece–Pieman 220 kV transmission line No. 1 and No. 2 circuits was caused by lightning.
2. The transmission line protection systems operated successfully, clearing the resulting blue phase-to-ground faults on each line circuit within 80 ms from fault inception, which is compliant with the maximum total fault clearance times required by the NER[14].
3. The possibility of a double circuit trip was correctly reclassified as a credible contingency event following the incident.
4. The power system remained in a secure operating state following the double circuit trip event.

[13] 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).

[14] See NER clause S5.1a.8.