AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Simultaneous trip of Tungatinah – Butlers Gorge – Derwent Bridge 110 kV Transmission Line and No. 1 and No. 2 Transformers at Tarraleah Power Station on 13 July 2019

January 2020

Reviewable Operating Incident Report under the National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	0539 hrs on 13 July 2019
Region of incident	Tasmania
Affected regions	Tasmania
Event type	Transmission equipment failure/Protection mal-operation
Generation impact	92 MW of generation was disconnected as a result of this incident
Customer load impact	2 MW of 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
HV	High voltage
kV	Kilovolt
NEM	National Electricity Market
NER	National Electricity Rules
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.

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1. Overview

This report relates to a reviewable operating incident[1] that occurred on 13 July 2019 in Tasmania. The incident involved the near simultaneous trip of the Tungatinah – Butlers Gorge – Derwent Bridge 110 kilovolt (kV) transmission line (TU-BG-DB line) and the No. 1 and No. 2 11/110 kV Transformers (No. 1 and No. 2 Transformers) at Tarraleah Power Station (TPS).

This incident resulted in the disconnection of 92 megawatts (MW) of generation, and 2 MW of customer load.

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[2].

AEMO has concluded that:

1. The trip of the TU-BG-DB line was caused by a broken conductor on the DB section of the line. The cause of the conductor failure was a combination of previous conductor damage and snow loading.
2. It is likely that protection operated correctly to clear the fault on the TU-BG-DB line, but this could not be conclusively determined in relation to Butlers Gorge.
3. The trip of the No. 1 and No. 2 Transformers at TPS was due to a protection grading issue. Hydro Tasmania plans to implement protection changes at the next station outage.
4. AEMO correctly reclassified the simultaneous trip of the TU-BG-DB line and No. 1 and No. 2 Transformers at TPS as a credible contingency. This reclassification will remain in place until protection changes are implemented at TPS.
5. The power system remained in a secure operating state.

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 TasNetworks[3], Hydro Tasmania[4], and AEMO.

National Electricity Market (NEM) time (Australian Eastern Standard Time [AEST]) is used in this report.

2. The incident

2.1 The incident

At 0539 hrs on 13 July 2019, the TU-BG-DB line tripped due to a high voltage fault on the line, resulting in the loss of 9 MW of generation at Butlers Gorge Power Station and 2 MW of customer load at Derwent Bridge.

Near simultaneously, the No. 1 and No. 2 Transformers at TPS tripped, resulting in the loss of all generation (83 MW) at TPS.

Refer to Appendix A for an overview of the relevant part of the power system immediately after the incident.

[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] See NER clause 4.8.15(b).

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

[4] Hydro Tasmania is a Generator in Tasmania.

A line patrol identified a fault on the Derwent Bridge (DB) section of the line. This section of the line was isolated, and the TU-BG section of the line was restored to service at 0910 hrs on 13 July. After completion of repairs, the DB section of the line was restored to service at 1606 hrs on 14 July 2019. All load at Derwent Bridge was also restored at this time.

The No. 1 and No. 2 Transformers at TPS were returned to service at 0955 hrs on 14 July 2019.

2.2 Trip of the TU-BG-DB line

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

At 0539 hrs on 13 July 2019, the TU-BG-DB line tripped due to a single phase to earth fault. TasNetworks conducted a line patrol and identified a broken conductor on the DB section of the line, approximately nine kilometres from the tee with the BG section.

Analysis has shown that the initial fault was a high resistance fault, due to the fallen conductor lying on snow covered ground resulting in a very low fault current of approximately 80 Amps. Due to the low fault current, the Zone 1 and Zone 2 protection elements at Tungatinah did not initially see the fault. The earth fault protection element did see the fault and initiated its timer[5].

After approximately 1.5 seconds, and before the earth fault protection timed out, the fault resistance reduced[6] and fault current increased to approximately 3,100 Amps. The fault was then seen by the Zone 2 protection element, which operated within 400 milliseconds to clear the fault. Although the NER[7] normally require that faults seen within Zone 2 are cleared within 220 milliseconds, the extended trip time of 400 milliseconds is allowable in certain circumstances[8].

For this incident all protection at Tungatinah operated correctly to clear the fault.

Hydro Tasmania advised that protection systems at Butlers Gorge operated to clear the fault within 1.3 seconds. This is consistent with the type of fault and the protection operation at Tungatinah. Hydro Tasmania further advised that, based on the fault clearance time, it believes the back-up overcurrent protection relay on the 110 kV side of the transformer at Butlers Gorge operated to clear the fault, but it is unable to provide any further information because the transformer protection indications at Butlers Gorge were overlooked and not recorded at the time of the incident.

The DB line section was isolated pending repairs, and the TU-BG line section was returned to service at 0910 hrs on 13 July.

Examination of the broken line conductor by TasNetworks found existing damage resulting from a flashover, likely caused by lightning. This flashover resulted in arc melt damage to some conductor strands and a number of broken conductor strands adjacent to an insulator clamp. Although this damage had been repaired by use of a mid-span splice, evidence showed the splice had not covered all the damaged section of the conductor, leaving a section of arc melt damage exposed at one end of the splice. Over time, localised stress and fatigue at the location of this damage resulted in the breakage of further strands of the conductor.

In the 24-hour period prior to the fault on 13 July 2019, heavy snowfall occurred in the central highlands area of Tasmania, with approximately 41 millimetres of rain/snow recorded at the Butlers Gorge weather station. As a result of the prior conductor damage and the heavy snow loading on the line, on 13 July 2019 the conductor failed completely.

Figure 1 shows a picture of the failed section of the conductor after the old mid-span splice had been removed, and shows evidence of strand failure prior to this incident.

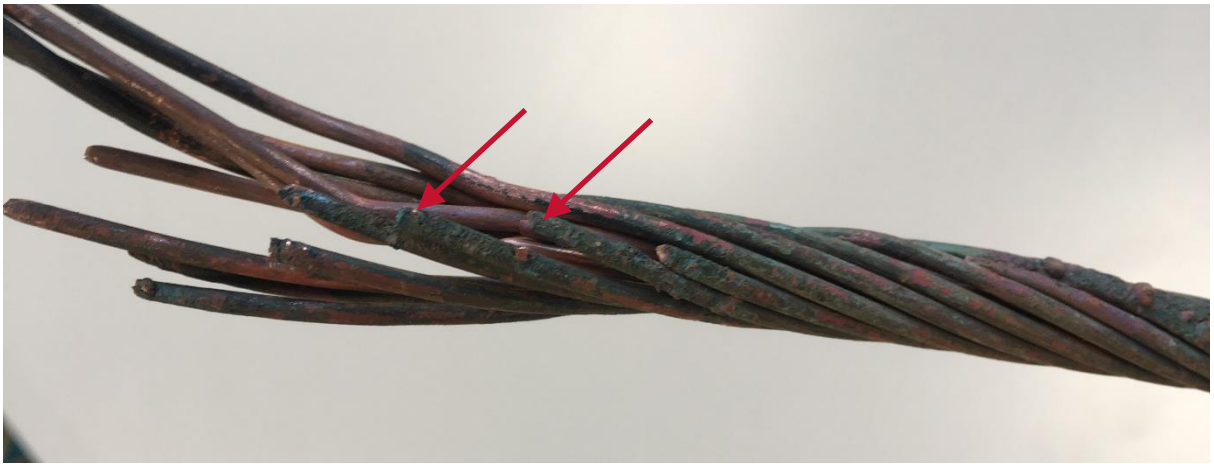
[5] The earth fault protection is an inverse time overcurrent protection. That is the lower the fault current the longer the time taken to operate.

[6] As the snow melted due to heat and the fallen conductor came in contact with the ground.

[7] Clause S5.1a.8(c).

[8] Refer NER clause S5.1a.8(g).

Figure 1 Failed section of conductor



Picture provided by TasNetworks.

The failed section of conductor was replaced, and the DB section of the line was returned to service at 1606 hrs on 14 July 2019.

Although the TU-BG-DB line is designed to withstand the level of snow loading often experienced in the area, and there have been no similar types of failure in the past, TasNetworks will continue to monitor conductor failure incidents on the TU-BG-DB line. If an increasing rate of failure is identified, then further investigations into the condition of the line conductors will be undertaken, including an inspection of any previous repairs.

2.3 Trip of the Transformers at Tarraleah Power Station (TPS)

The following is based on information provided by Hydro Tasmania.

Coincident with the fault on the TU-BG-DB line, the No. 1 and No. 2 transformers at TPS tripped resulting in the loss of all generation (83 MW) at TPS. This was not an expected outcome for the fault on the TU-BG-DB line.

Hydro Tasmania engaged Entura[9] to determine the cause of the outage at TPS.

Based on available fault data and relay testing results, it was determined that the protection on No. 1 and No. 2 Transformers operated as designed.

However, the protection on the TU-BG-DB line cleared the fault in approximately 1.5 seconds, while the earth fault protection on the No. 1 and No. 2 transformers was set to trip after 1.4 seconds. That is, the protection on the transformers operated before the fault on the TU-BG-DB line had been cleared.

Hydro Tasmania is planning to upgrade the protection on the transformers at TPS, with this work expected to be completed in February 2020 during a planned station outage.

Because of this incident, AEMO has reclassified the simultaneous trip of the TU-BG-DB line and the No. 1 and No. 2 Transformers at TPS as a credible contingency until the protection issue is resolved. See Section 3.2 of this report for further details.

Hydro Tasmania has also confirmed a similar issue is unlikely elsewhere in the network, because the earth fault protection on the transformers at TPS is a remnant of an old protection scheme at Tarraleah which was not replaced during a recent protection upgrade.

[9] Entura is a consultancy firm owned by Hydro Tasmania.

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[10].

The power system was in a secure operating state prior to this incident and remained in a secure operating state for the duration of the incident. The only action required by AEMO was to invoke constraint set T-TA_ZERO[11] to ensure the TPS did not receive a dispatch target while unable to generate.

3.1 Frequency response

As a result of the loss of 92 MW of generation at the Tarraleah and Butlers Gorge Power Stations, the frequency in Tasmania fell to a minimum of 49.65 Hertz (Hz) and recovered to above 49.85 Hz within three seconds.

The frequency standard in Tasmania was met for this incident.

3.2 Reclassification

AEMO assessed whether to reclassify these incidents as a credible contingency event[12].

After the No. 1 and No. 2 Transformers at TPS were returned to service at 0955 hrs on 14 July 2019, Hydro Tasmania was not able to confirm that a further trip was unlikely. As such, at 0955 hrs on 14 July 2019, AEMO reclassified the simultaneous trip of the TU-BG-DB line and both the No. 1 and No. 2 Transformers at TPS as a credible contingency.

This reclassification will remain in place until Hydro Tasmania has resolved the protection issue at TPS. This is not expected until February 2020.

No constraint sets were required to be invoked as a result of this reclassification.

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[13] 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[14].

[10] 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.

[11] T-TA_ZERO – limit generation at Tarraleah PS to zero MW.

[12] 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).

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

[14] 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 10.3.

- AEMO issued Market Notice 68969 at 0644 hrs on 13 July 2019, 65 minutes after the event, to advise of the non-credible contingency event.

2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical[15].
   - AEMO issued Market Notice 68974 at 1024 hrs on 14 July 2019 to advise that AEMO had reclassified the incident as a credible contingency until further notice.

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 trip of the TU-BG-DB line was caused by a broken conductor on the DB section of the line. The cause of the conductor failure was a combination of previous conductor damage and snow loading.
2. It is likely that protection operated correctly to clear the fault on the TU-BG-DB line, but this could not be conclusively determined in relation to Butlers Gorge.
3. The trip of the No. 1 and No. 2 Transformers at TPS was due to a protection grading issue. Hydro Tasmania plans to implement protection changes at the next station outage.
4. AEMO correctly reclassified the simultaneous trip of the TU-BG-DB line and No. 1 and No. 2 Transformers at TPS as a credible contingency. This reclassification will remain in place until protection changes are implemented at TPS.
5. The power system remained in a secure operating state.

[15] 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).

A1. System diagram

The diagram below shows the relevant part of the power system immediately after the incident