AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Trip of Chalumbin–Woree 876 and 877 275 kV transmission lines on 17 February 2018

November 2018

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.

DISCLAIMER

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INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1926 hrs on 17 February 2018
Region of incident	Queensland
Affected regions	Queensland
Event type	Lightning combined with unexpected protection operation
Generation Impact	30 MW of generation lost
Customer load impact	204 MW of customer load lost
Associated reports	Nil

Contents

1. Overview

This report relates to a reviewable operating incident[1] that occurred on 17 February 2018 in Queensland. This incident involved the outage of the 876 and 877 Chalumbin–Woree 275 kV transmission lines (876 line and 877 line) and No. 1 275 kV busbar at Chalumbin.

There was a loss of 30 MW of generation and 204 MW of customer load as a result of this incident.

As this was a reviewable operating incident, AEMO is required to assess power system security over the course of this incident and 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. Lightning resulted in two separate high voltage faults on the 877 line.
2. The second high voltage fault on the 877 line caused an external flashover of circuit breaker (CB) 8772 at Chalumbin, resulting in the outage of the No. 1 275 kV busbar at Chalumbin and the 877 line.
3. An unexpected protection operation at Woree resulted in the trip of the 876 line and subsequent loss of load in Far North Queensland. Powerlink updated the protection in August 2018.
4. AEMO correctly reclassified this non-credible contingency as a credible contingency, until sufficient information was available to determine there was no reasonable risk of a reoccurrence.
5. The power system remained in a secure operating state during this incident.

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 Powerlink[3] and from AEMO's Energy Management Systems.

National Electricity Market Time (Australian Eastern Standard Time) is used in this report.

2. Pre-incident conditions

At 1518 hrs on 17 February 2018, AEMO had reclassified the simultaneous trip of the 857 and 858 Ross–Chalumbin 275 kV transmission lines (857 and 858 lines) as a credible contingency, due to lightning in the area[4]. This was in accordance with normal operating procedures[5].

As a result of this, to ensure the power system remained in a secure operating state, the parallel 132 kV network was split at Innisfail and Tully to ensure the 132 kV network was not overloaded if both 857 and 858 lines tripped. This is in accordance with Powerlink's normal operating procedures.

Appendix A1 provides an overview of the Far North Queensland power system prior to this 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] Powerlink is transmission network service provider (TNSP) for the area in question.

[4] Refer to Market Notice 61359.

[5] Refer to SO_OP 3715 - Power System Security Guidelines. Available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3715---Power-System-Security-Guidelines.pdf.

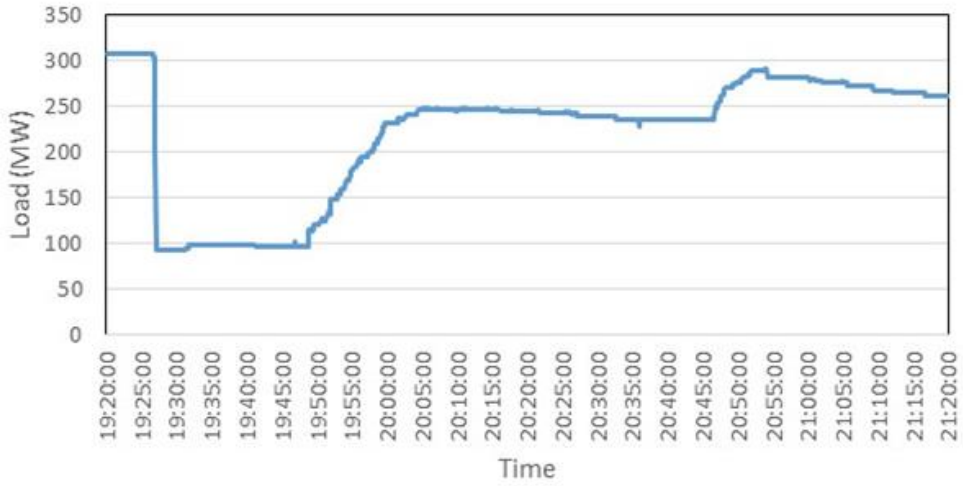
3. The incident

At 1926 hrs on Saturday 17 February 2018, the 876 and 877 lines and the No. 1 275 kV busbar at Chalumbin tripped near simultaneously, resulting in the loss of 204 MW customer load in Far North Queensland. Barron Gorge unit 2 was online at 30 MW and tripped as designed, due to AVR failure as a result of the low system voltage.

The 876 line was returned to service at 1941 hrs on 17 February. Load restoration commenced at

1948 hrs and all load restored by 2055 hrs on 17 February, as shown in Figure 1.

Figure 1 Far North Queensland load



The No.1 275 kV busbar at Chalumbin was returned to service at 0059 hrs on 18 February, and the 877 line was returned to service at 1458 hrs on 19 February, after repairs to a CB at Chalumbin were completed.

Refer to Appendix A2 for a detailed sequence of events.

As the simultaneous trip of multiple transmission lines and a busbar is not an expected event, this is a non-credible contingency and hence a reviewable operating incident. In accordance with clause 4.8.15 of the NER, AEMO is required to review and report on any reviewable operating incident

4. Incident analysis

The following is based on information provided by Powerlink as transmission network service provider (TNSP) for the area in question.

During this incident there were two high voltage faults combined with an unexpected protection operation. Each of these is discussed below.

4.1 High voltage fault 1 – 877 line

At 19:26:38.319 hrs on 17 February 2018, a single phase ('B' phase) fault occurred on the 877 line during a period of severe lightning activity in the area. This resulted in a single phase trip of CB 8772 at Woree and CBs 8772 and 5062 at Chalumbin to clear the fault. Protection operated as expected, and the fault was cleared in 46 ms[6].

4.2 High voltage fault 2 – CB 8772 at Chalumbin

At 19:26:38.570 hrs on 17 February 2018, before the auto-reclose on 877 line had time to operate and reclose the faulted phase, a further lightning strike to the de-energised 'B' phase conductors of 877 line caused an external flashover across the open phase of CB 8772 at Chalumbin. This high voltage fault was cleared by operation of the CB Fail Protection at Chalumbin to trip all three phases of CBs 5062, 8772, 8572, and 8582 at Chalumbin and CB 8772 at Woree, resulting in the outage of the 877 line and No. 1 275 kV busbar at Chalumbin. Protection operated as expected and the fault was cleared in 230 ms[7].

The No. 1 275 kV busbar at Chalumbin was returned to service at 0059 hrs on 18 February, after CB 8772 had been isolated for inspection/repairs.

The 877 line was returned to service at 1458 hrs on 19 February, after repairs to CB 8772 were completed.

4.3 Trip of 876 line at Woree

At 19:26:38.829 hrs on 17 February 2018, CB 8762 at Woree tripped single phase as the result of the unexpected operation of the 876 line 'Y' protection at Woree. There was no high voltage fault on the 876 line associated with this protection operation.

Although this CB has single phase auto-reclose installed, an auto-reclose was not initiated, because the auto-reclose criteria were not met. As this line has both an underground cable section and an overhead line section, an auto-reclose is only initiated if a high voltage fault is determined as being on the overhead section. As there was no high voltage fault anywhere on the line, the conditions for initiation of the auto-reclose were not met.

Consequently, after approximately five seconds, CB 8762 Pole Discrepancy protection timed out and tripped all three phases according to design. This action resulted in the majority of the Far North Queensland network being disconnected from the rest of the power system. The 876 line remained energised from Chalumbin.

The 876 line was returned to service at 1941 hrs on 17 February.

See Appendix A1 for an overview of the Far North Queensland power system immediately after this incident.

4.4 Follow-up

The operation of the 876 line 'Y' protection at Woree should not have happened for this incident. Post incident analysis has determined the protection operated due to the extended time taken for the CB Fail protection to operate and clear the fault on CB 8772 at Chalumbin.

Powerlink sought assistance from the relay manufacturer on this unexpected protection operation, and, based on their advice, Powerlink modified the protection to minimise the risk of any future reoccurrence.

AEMO does not consider there is an increased risk of the simultaneous loss of both 876 and 877 lines. AEMO, in accordance with NER clause 4.2.3(b), does not consider the operation of CB Fail Protection as reasonably possible under normal circumstances. That is, operation of a CB Fail Protection is not a credible contingency.

[6] The NER require faults of this type to be cleared within a maximum of 120 ms.

[7] The NER require faults of this type to be cleared within a maximum of 250 ms.

Powerlink has confirmed that the combination of the 'Y' protection design in service and the primary system configuration of the 876 and 877 lines is unique to these lines and not replicated elsewhere in the Powerlink network.

5. Power system security

AEMO is responsible for power system security in the National Electricity Market (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].

This section assesses how AEMO managed power system security over the course of this incident.

The power system was in a secure operating state prior to this incident and remained in a secure operating state during the incident. No specific action was required by AEMO to restore or maintain power system security during this incident.

AEMO correctly invoked constraint sets Q-KMBG_7134 and Q-KMBG_7184[9] to ensure that the Barron Gorge generating units did not receive a dispatch target while disconnected from the power system.

At 2035 hrs on 17 February, the 132 kV network between Innisfail and Tully was returned to its normal configuration to provide improved redundancy to the Far North Queensland area while the 877 line was still out of service. At 2050 hrs, the flow into Far North Queensland exceeded the secure limit of 200 MW. After discussion with Powerlink as to whether the 132 kV network should be split again, AEMO determined no action was required as the flow was expected to reduce to below 200 MW within a short period. The maximum flow reached was 217 MW, and it reduced to below 200 MW by 2105 hrs.

5.1 Reclassification

5.1.1 No. 1 275 kV busbar at Chalumbin

AEMO was advised the trip of the Chalumbin No. 1 275 kV busbar resulted from the operation of the CB Fail protection associated with CB 8772. As this CB remained out of service when the busbar was restored, there was no requirement to reclassify the loss of the busbar as a credible contingency.

5.1.2 876 & 877 lines

At 1458 hrs on 19 February, after the 877 line had been returned to service, AEMO had insufficient information to determine whether the simultaneous trip of the No. 1 275 kV busbar at Chalumbin and both 876 and 877 lines was no longer reasonably possible. As such, AEMO reclassified the loss of the No. 1 275 kV busbar at Chalumbin and both 876 and 877 lines as a single credible contingency at 1500 hrs on 19 February 2018.

On 20 February 2018, Powerlink advised AEMO that:

- The No. 1 275 kV busbar outage at Chalumbin was caused by a flashover on CB 8772 and the CB had been repaired prior to being returned to service.
- The operation of 876 line 'Y' Protection at Woree and subsequent tripping of CB 8762 was associated with the operation of the CB Fail Protection on CB 8772 at Chalumbin.

[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] Out = Barron Gorge to Kamerunga 7134 and 7184 132kV lines.

Although this unexpected protection operation was still under investigation, AEMO and Powerlink agreed there was no increased risk of the loss of the 876 line for the credible loss of the 877 line, because the operation of CB Fail Protection is not considered as a credible contingency.

AEMO cancelled the reclassification of these lines and the Chalumbin busbar at 1220 hrs on 20 February 2018.

6. 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[10] over the course of this incident.

For this incident, AEMO was required to inform the market on the following matters:

1. A non-credible contingency event - notify within two hours of the event[11].
   - AEMO issued Market Notice 61363 at 1942 hrs – 16 minutes after the event.
2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical[12].
   - AEMO issued Market Notice 61390 at 1506 hrs on 19 February 2018 to advise participants of the reclassification of 876 and 877 lines and No. 1 busbar at Chalumbin as a credible contingency.
   - AEMO issued Market Notice 61412 at 1227 hrs on 20 February 2018 to advise participants of the cancellation of the reclassification.

Over the course of this incident, AEMO issued appropriate, timely, and sufficiently detailed market information.

7. 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. Lightning resulted in two separate high voltage faults on the 877 line.
2. The second high voltage fault on the 877 line caused an external flashover of CB 8772 at Chalumbin resulting in the outage of the No. 1 - 275 kV busbar at Chalumbin and the 877 line.
3. An unexpected protection operation at Woree resulted in the trip of the 876 line and subsequent loss of load in Far North Queensland. Powerlink has updated the protection in accordance with recommendations from the relay manufacturers to minimise the risk of a re-occurrence.

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

[11] 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.

[12] 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).

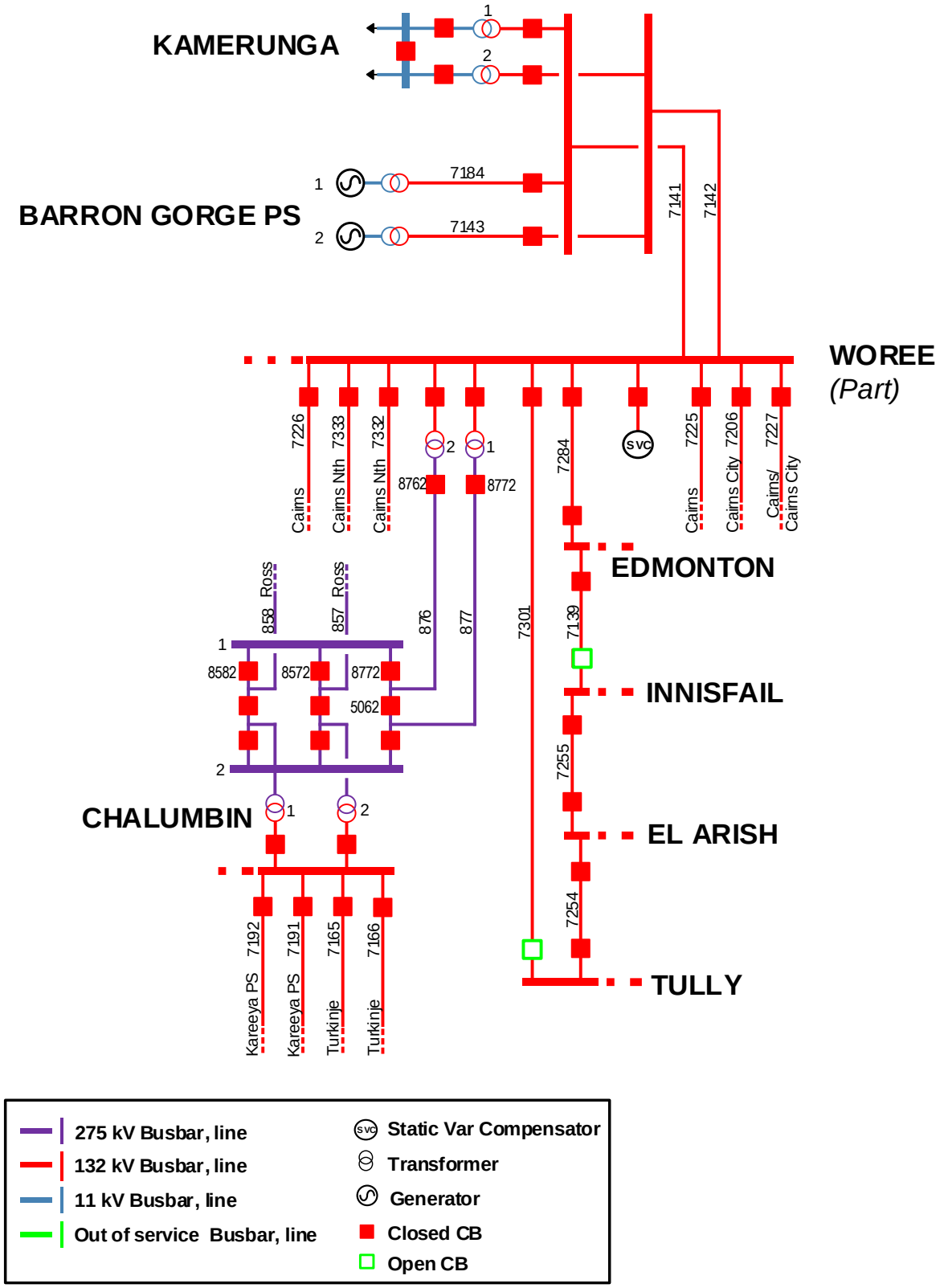
4. AEMO correctly reclassified this non-credible contingency as a credible contingency until sufficient information was available to determine there was no reasonable risk of a reoccurrence.
5. The power system remained in a secure operating state during this incident.

8. Pending actions

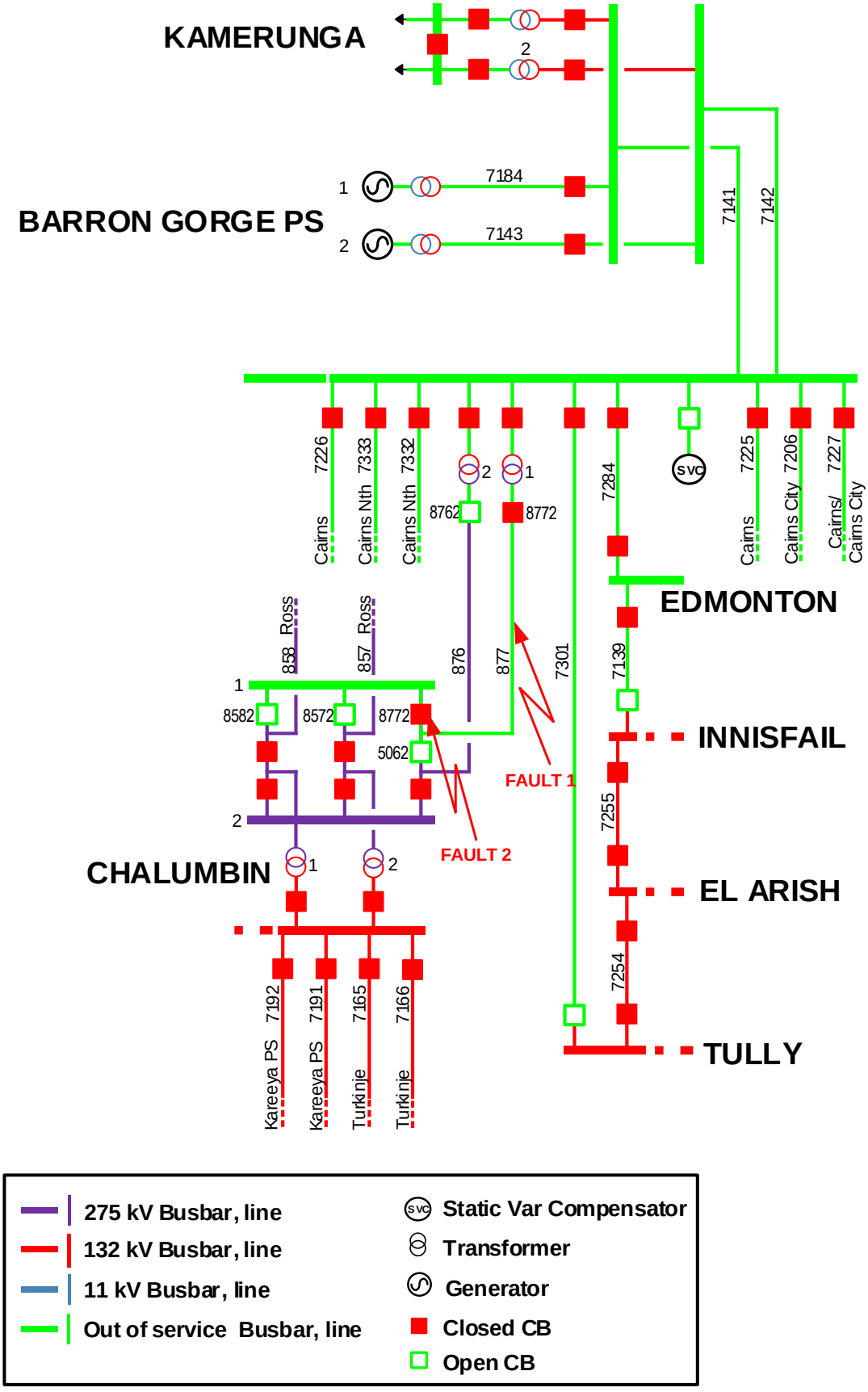
Powerlink completed changes to the 'Y' Protection Systems on the 876 and 877 lines.

A1. Power system diagram

The diagram below shows the power system in Far North Queensland prior to the incident.



The diagram below shows the power system in Far North Queensland immediately after the incident.



A2. Sequence of events

Date/time	Event
15/02/2018	
15:18 hrs	Simultaneous trip of Ross–Chalumbin 857 and 858 lines reclassified as a credible contingency due lightning. 132 kV network split between Woree and Tully.
19:26:38.319 hrs	Single phase to earth fault on 877 line.
19:26:38.356 hrs	877 line single phase trip at Chalumbin and Woree. Fault cleared.
19:26:38.570 hrs	Single phase to earth fault on 877 line. Flashover across the open phase on CB 8772 at Chalumbin.
19:26:38.800 hrs	Operation of CB Fail Protection on CB 8772 at Chalumbin resulting in the trip of: • No. 1 275 kV busbar at Chalumbin. • 877 line.
19:26:38.829 hrs	CB 8762 at Woree – single phase trip.
19:26:39 (approx.)	CB 8772 at Chalumbin and Woree auto-reclose. No. 1 busbar at Chalumbin re-energised.
19:26:43.829 hrs	CB 8762 at Woree – three phase trip. Loss of load in Far North Queensland. Barron Gorge unit 2 tripped from 30 MW. No. 1 busbar at Chalumbin de-energised.
19:41 hrs	876 line returned to service. AEMO clearance to Powerlink to restore load.
19:42 hrs	Market Notice 61363 issued. Advice of a non-credible contingency.
19:44 hrs	The following elements were returned to service: • Woree No. 2 275/132 kV transformer. • 7206 Woree–Cairns City 132 kV line.
19:48 hrs	The following elements were returned to service: • 7284 Edmonton–Woree 132 kV line. • Edmonton No. 1 and No. 2 transformers.
19:51 hrs	The following elements were returned to service: • 7227 Woree–Cairns 132 kV line. • Cairns No. 4 transformer.
20:07 hrs	Woree 132 kV SVC returned to service.
20:10 hrs	7227 Woree–Cairns 132 kV line returned to service.
20:35 hrs	132 kV network between Woree and Tully returned to normal.
20:40 hrs	Constraint sets Q-KMBG_7143 and Q-KMBG_7184 invoked.
20:46 hrs	The following elements were returned to service: • 7142 Woree–Kamerunga 132 kV line. • Kamerunga No2 transformer.
20:55 hrs	Powerlink advised AEMO that all load restored.
22:30 hrs	Constraint sets Q-KMBG_7143 and Q-KMBG_7184 revoked.

Date/time	Event
23:19 hrs	Reclassification of the simultaneous trip of Ross–Chalumbin 857 and 858 lines as a credible contingency cancelled.
18/02/2018	
00:59 hrs	Chalumbin No. 1 275 kV busbar returned to service.
19/02/2018	
15:00 hrs	877 line and Woree No. 1 275/132 kV transformer returned to service.
15:00 hrs	Reclassification of 876 line, 877 line, and Chalumbin No. 1 busbar as a credible contingency. Market Notice 61390 issued at 15:06 hrs.
20/02/2018	
12:20 hrs	Reclassification of 876 line, 877 line, and Chalumbin No. 1 busbar as a credible contingency cancelled. Market Notice 61412 issued at 12:27 hrs.