WATERLOO BUS TRIPPINGS BETWEEN 6 DECEMBER 2010 AND 3 FEBRUARY 2011

PREPARED BY: Electricity System Operations Planning and Performance

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FINAL

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1 Introduction

The 132 kV bus zone B protection system operated at Waterloo 132kV substation in South Australia on four separate occasions, on 6 & 7 December 2010, 14 January 2011 and 3 February 2011. On each occurrence, the Waterloo 132 kV bus Zone B circuit breakers CB6189 and CB6014 opened and intertrip was sent to both Mintaro and Hummocks. This led to the de-energization of the Waterloo bus Zone B, Mintaro – Waterloo and Hummocks – Waterloo 132 kV transmission lines.

This report has been prepared under clause 4.8.15 of the Rules 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.

The report has been prepared using information obtained from ElectraNet and AEMO's Energy Market System.

All references to time in this report refer to Market Time (Australian Eastern Standard Time).

2 Summary of Events

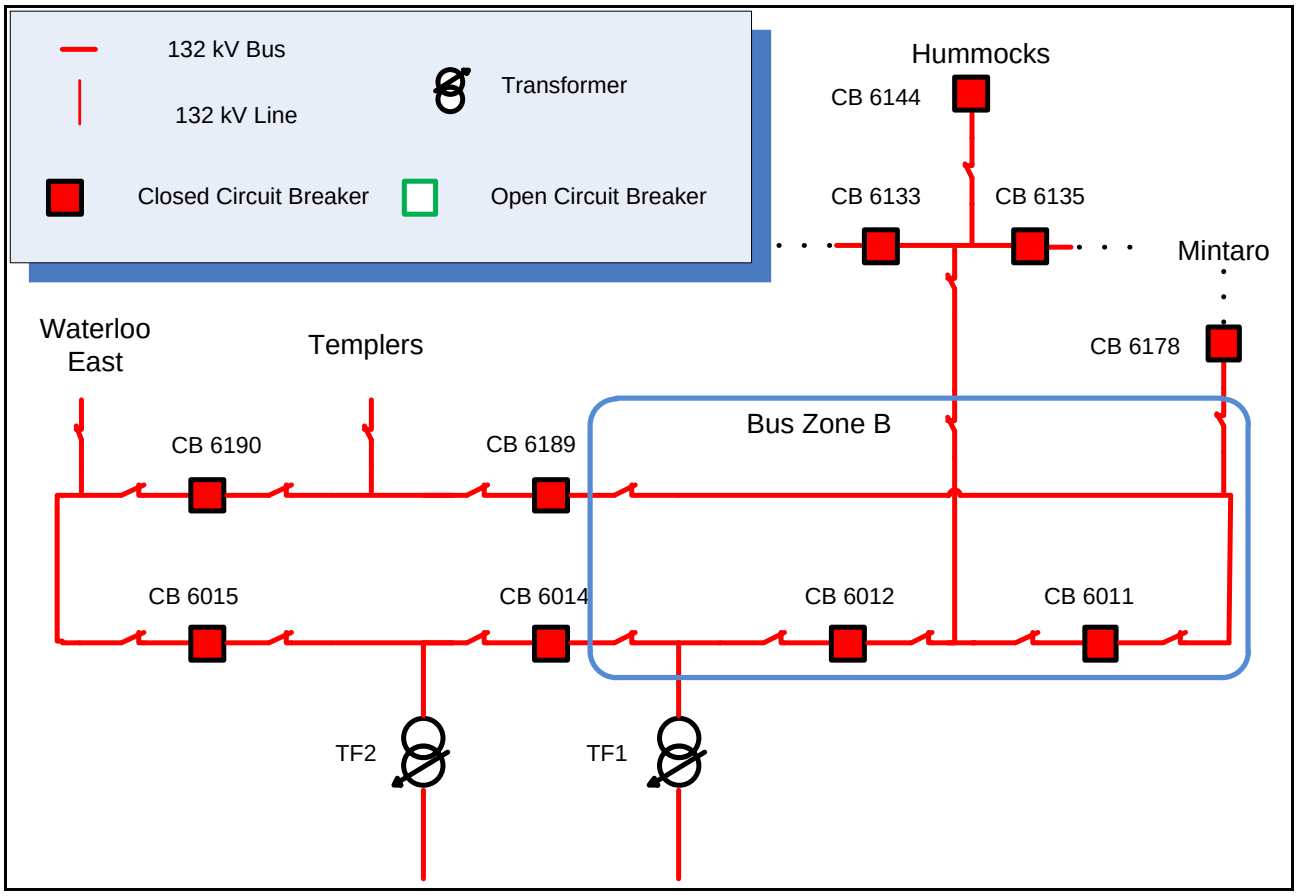


Figure 1 132 kV system configuration at Waterloo substation

In all of the tripping occasions, the sequence below occurred as designed:

Time	Event
00 ms	Waterloo Bus Zone B – Trip & Earth Leakage Trip
30 ms	Hummocks Line Intertrip Signal Sent
49 ms	CB 6144 at Hummocks Open
54 ms	CB 6135 at Hummocks Open
75 ms	CB 6014 & 6189 at Waterloo Open
89 ms	CB 6133 at Hummocks Open
290 ms	CB 6178* at Mintaro Open

Table 1 Operation of circuit breakers following operation of Waterloo 132 kV substation bus zone B protection system

*Mintaro CB 6178 auto-reclosed on three occasions (7 December 2010, 14 January 2011 and 3 February 2011) following the B busbar trip. Electranet is investigating whether the auto-reclosing was the correct operation.

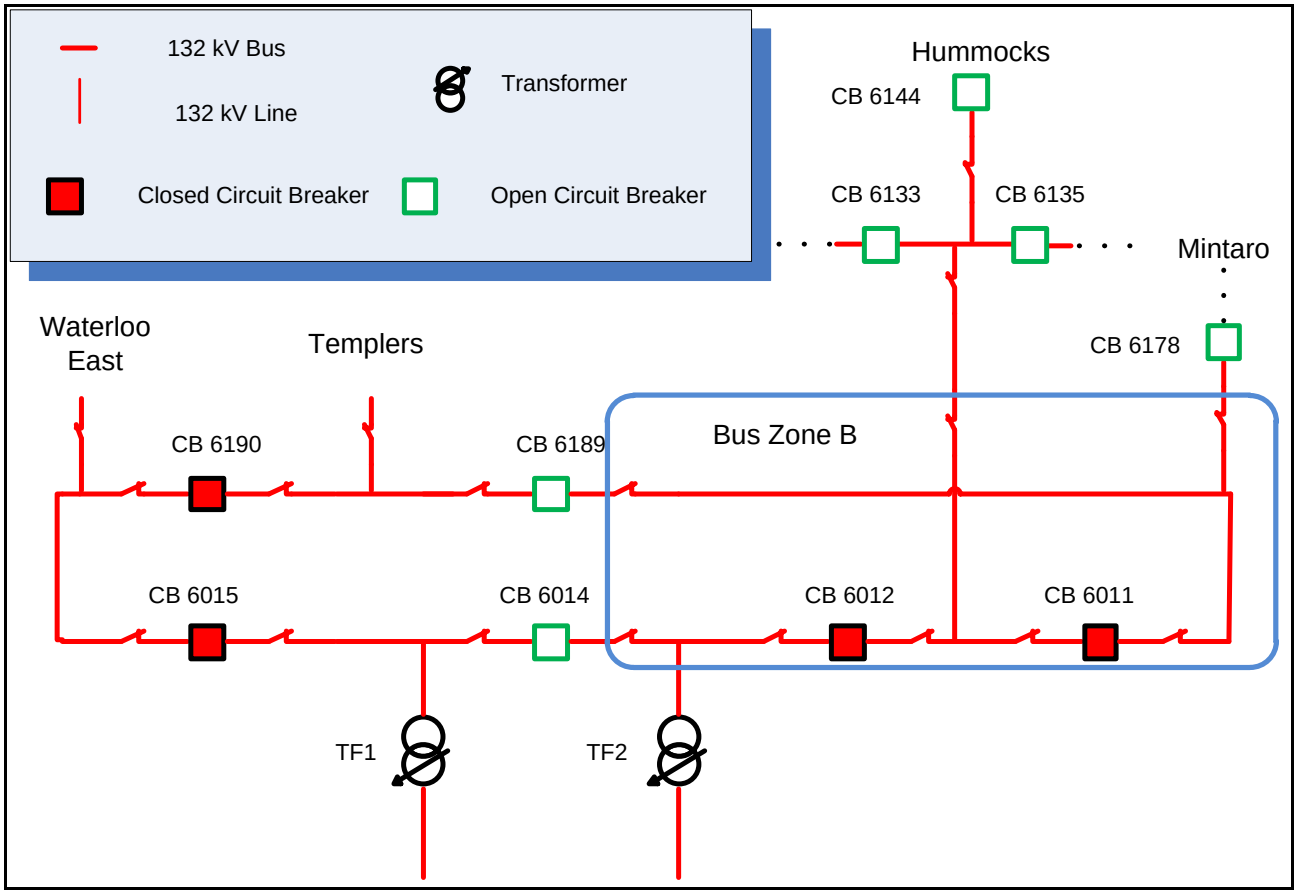


Figure 2 Waterloo 132 kV bus configuration following the operation of the B bus zone protection

NB: There was considerable rainfall in the area during all of these tripping events

06 December 2010 Event

On Monday 06 December 2010 at 23:01 hrs, the bus zone B protection system operated to trip the circuit breakers listed in Table 1. The Mintaro – Brinkworth 132 kV transmission line was out of service on a planned outage and Mintaro power station was not generating at the time.

The AEMO control room invoked constraint set S-HUWT (Out = Hummocks – Waterloo 132 kV line) from 23:15 on 6 December to 03:25 hrs on 7 December 2010. Market Notices 33583 & 33584 were issued to advise the market of the non-credible contingency event.

The Hummocks – Waterloo 132 kV transmission line was returned to service at 03:20 hrs on 7 December 2010.

ElectraNet could not find a cause for the trip at the time and testing did not identify any issues with protection systems. At 11:56 hrs on 7 December 2010, the Waterloo 132 kV B bus was returned to service

The Mintaro – Brinkworth 132 kV transmission line was returned to service at 12:20 hrs on 7 December 2010

07 December 2010 Event

On Tuesday 7 December 2010 at 15:35 hrs, the Waterloo 132 kV bus zone B protection system operated to trip the circuit breakers listed in Table 1.

The Hummocks – Waterloo 132 kV transmission line was returned to service at 18:06 hrs.

ElectraNet isolated the Waterloo bus zone B to conduct further investigations to determine the cause of the trippings. A number of damaged insulator stacks were found on the Waterloo B bus zone. These insulators were replaced before the busbar was returned to service on 9 December 2010.

Constraint set S-HUWT was invoked from 1550 hrs to 18:40 hrs following the trip. Market Notice 33605 was issued to advise the market of the non-credible contingency event.

14 January 2011 Event

On Friday 14 January 2011 at 01:49 hrs, the Waterloo 132 kV bus zone B protection system operated to trip the circuit breakers in Table 1. Market Notices 34058 and 34068 were issued to advise the market of the non-credible contingency event. In addition, AEMO invoked the S-HUWT constraint set from 02:30 until 05:20 hrs.

The Hummocks – Waterloo 132kV transmission line was restored at 05:18 hrs on 14 January but the Mintaro - Waterloo 132kV transmission line and Waterloo 132 kV bus zone B busbar were left isolated until 19:14 hrs on 15 January 2011 to allow Electranet to carry out further fault investigations.

Several cracked insulator discs that were found on the Mintaro - Waterloo 132kV transmission line isolator 6165 were replaced before the busbar was reenergised. Some insulators that showed signs of pollution were also cleaned on the day.

Electranet also carried out HV tests on the cracked porcelain insulators that had been removed. These tests showed that the cracked porcelain insulators could flash over when excessive moisture was applied. See photograph in Appendix 2. Heavy rainfall was experienced during all of the tripping occurrences mentioned in this report.

03 February 2011 Event

On Thursday 03 February 2011 at 16:13 hrs, the Waterloo 132 kV bus zone B protection system operated. AEMO invoked constraint set S-HUWT from 16:25 hrs on 03 February until 13:00 on 5 February 2011 when the bus was reenergised. Market Notice 34359 was issued to inform the market.

This time the search for the cause of the bus zone tripping included the use of specialized binoculars. The binoculars were able identify that the T phase on the Western side of the busbar had flashed over. The flash over was not previously identified because the failed insulators were at a considerable height above ground. The polymeric insulators (LAPP type) on the Western side had tracked but the tracking marks were not facing the ground. Flashovers were occurring underneath rubber sheaths that had tracked along the fiberglass core.

All LAPP type polymeric insulators at Waterloo substation were replaced on 04 February 2011. The removed LAPP insulators were HV tested to assess their condition. Although the insulators passed the tests for wet and dry conditions, their deterioration and susceptibility to high voltages was noted. The flashed LAPP insulators were dissected to confirm the level of damage. See photographs in Appendix 1.

3 Power System Security Assessment

The multiple tripping of the Waterloo 132 kV bus zone B led to the off loading of the Mintaro - Waterloo and Hummocks - Waterloo 132 kV transmission lines. Throughout the period when the busbar and transmission lines were out of service the power system remained in a secure operating state. The power system frequency remained within the normal operating frequency band.

4 Follow Up Actions

ElectraNet will investigate and, if necessary, rectify the auto-reclosing scheme of the Mintaro - Waterloo 132kV transmission line to ensure no reclose operation will occur when an intertrip is sent by the Waterloo 132kV bus zone protection.

5 Conclusion

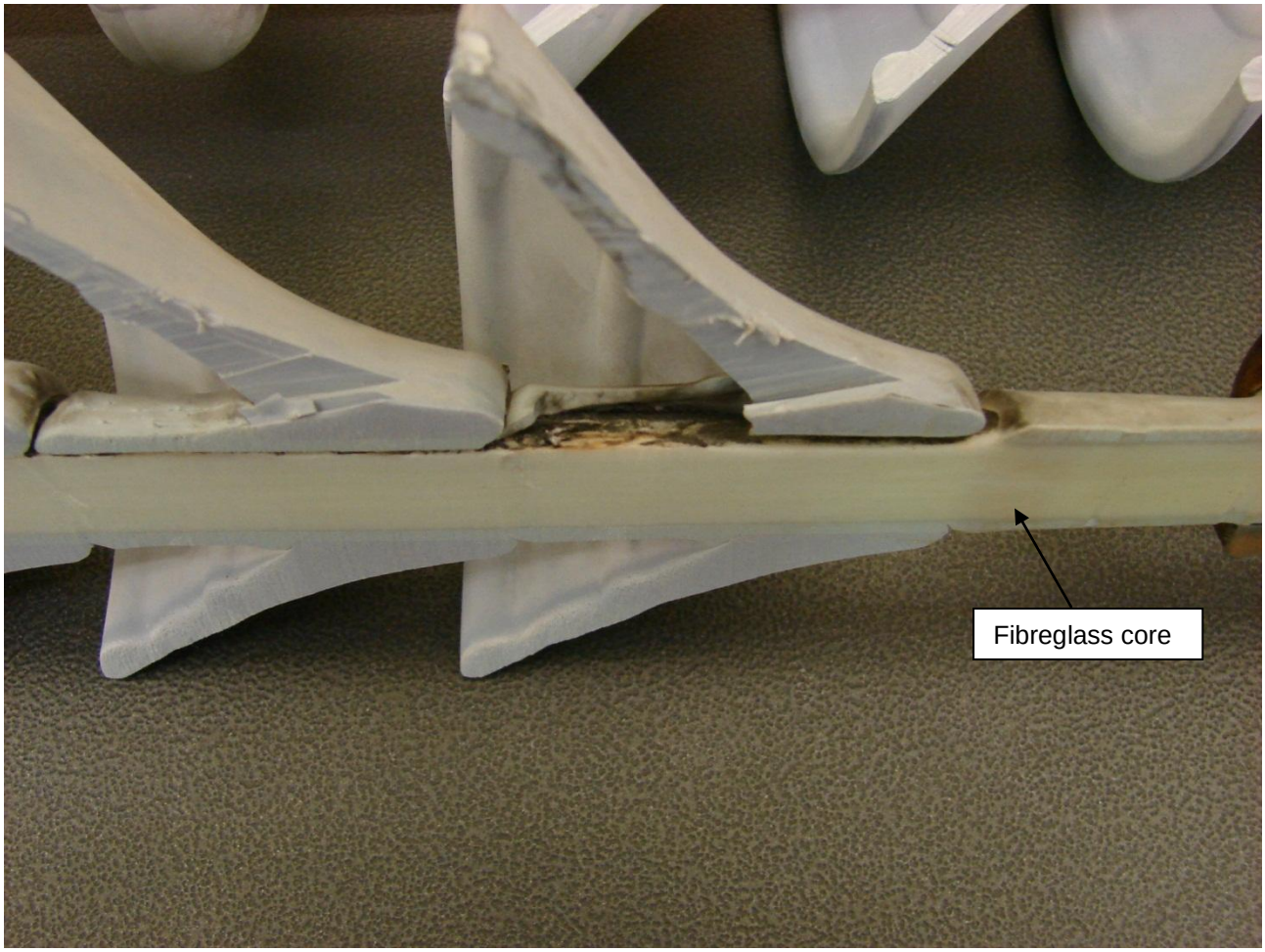
The Waterloo 132 kV bus zone B tripped on the operation of bus zone protection on four separate occasions - on 6 and 7 December 2010, 14 January 2011 and 3 February 2011. The bus zone protection system operated as designed. Damaged LAPP type polymeric insulators on the Western side of the bus were the root cause of the four incidents. See photographs of the damage caused by the flash over under LAPP insulator in Appendix 1. All the LAPP type polymeric insulators at Waterloo have since been replaced.

6 Recommendation

ElectraNet will inform AEMO of the outcome of its investigation into the auto-reclosing of Mintaro - Waterloo 132 kV transmission line at Mintaro, by the end of May 2011.

7 Appendix 1

Figure 3 Damage caused by flashover occurring underneath the rubber sheaths


Fibreglass core

8 Appendix 2

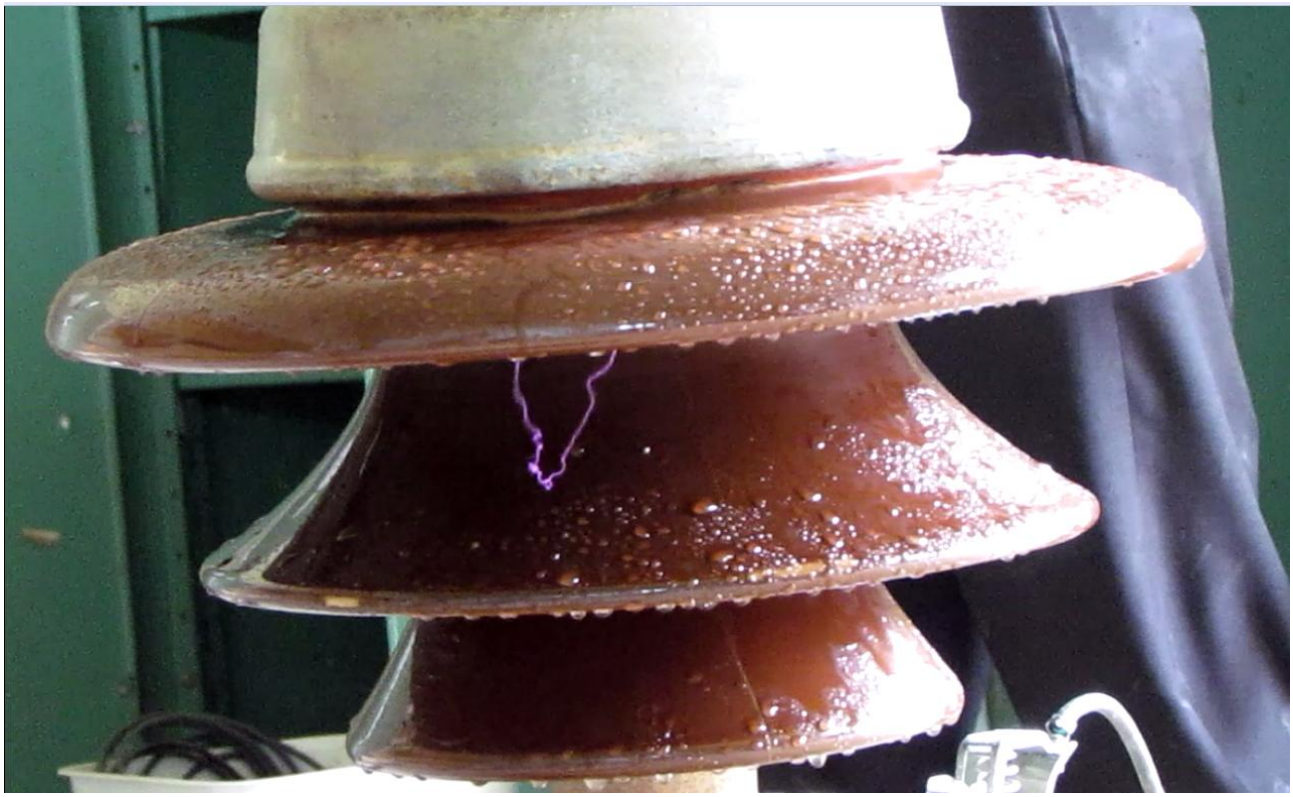


Figure 4 Flashover occurring during moisture tests