POWER SYSTEM INCIDENT REPORT SIMULTANEOUS LOSS OF NO.1 MOUNT BEAUTY TO DEDERANG AND MOUNT BEAUTY TO MACKAY CREEK TEE BOGONG 220 KV LINES ON 24 JANUARY 2011

PREPARED BY: ESOPP

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FINAL

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1 Introduction

On 24 January 2011, a power system incident took place within the SP AusNet and AGL Southern Hydro (AGL) networks. At 1337 hrs on this day the No.1 Mount Beauty to Dederang (MBTS to DDTS) 220 kV line tripped and auto-reclosed following a phase to phase fault on the line.

Immediately after the auto-reclose of the MBTS to DDTS 220 kV line, the Mount Beauty to Mackay Creek (MKPS) tee Bogong (BOPS) 220 kV line tripped, interrupting 197 MW of generation at BOPS and MKPS. This part of the network belongs to AGL.

This report has been prepared under clause 4.8.15 of the National Electricity 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.

Information for this report has been provided by SP AusNet and AGL. Additional information has been obtained from AEMO's Energy Management System and Market Management System.

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

2 Summary of Events

On 24 January 2011, the Mount Beauty 220 kV terminal station (MBTS) was operating in its system normal configuration. Refer to Figure 1 for the network configuration in the vicinity of Mount Beauty 220 kV terminal station and the connections to Dederang 220 kV terminal station (DDTS), as well as Mackay and Bogong power stations, before the incident took place.

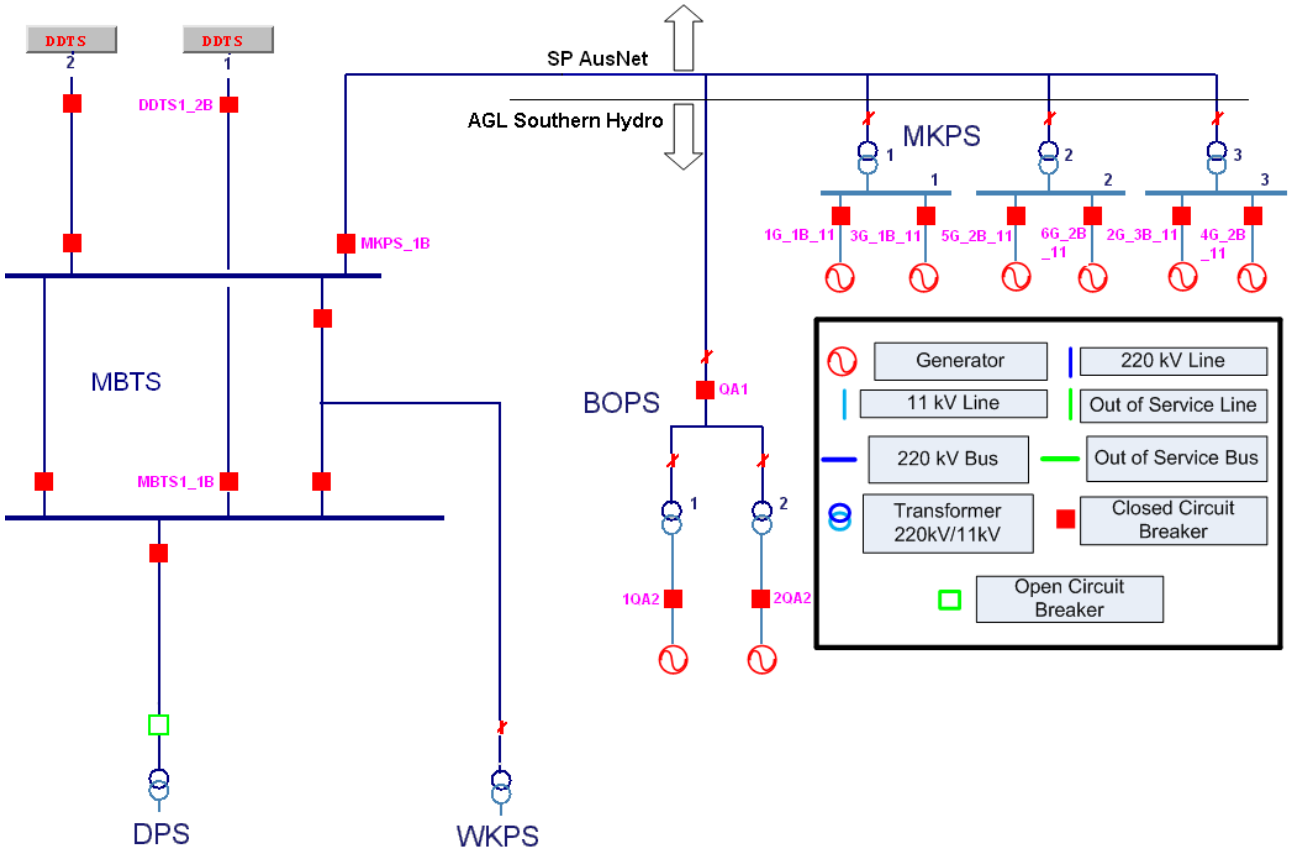

Figure 1 –Network in the vicinity of SP AusNet's MBTS switchyard and AGL's MKPS and BOPS before the incident

At 1337 hrs the No.1 MBTS to DDTS 220 kV line tripped and auto-reclosed following a white to blue phase fault close to the DDTS end. The disturbance recording data received from SP AusNet and AGL showed the existence of neutral to earth currents on the MKPS and BOPS generator transformers and increasing earth fault currents on the No.1 MBTS to DDTS 220 kV line, immediately prior to the trip of this line. The earth fault on the line developed into a two phase to

earth fault within a very short time. The transmission line protection system operated and the fault was successfully cleared within the required timeframe specified in the National Electricity Rules[1] (NER), as follows:

- At the DDTS end, both X and Y protection operated in Zone 1 and the fault was cleared in 63 milliseconds.
- At the MBTS end, both X and Y protection operated in carrier-aided Zone 2 and the fault was cleared in 82 milliseconds.

The No.1 MBTS to DDTS 220 kV line auto-reclosed first at the MBTS end as this is the live line blocking end followed by the DDTS end with synchronism check. Auto-reclose was successful at both ends.

Though the No.1 DDTS to MBTS 220 kV line auto-reclosed successfully the white phase conductor of the line had broken at the DDTS end during the fault, resulting in power transfer on two phases only and causing the parallel No.2 MBTS to DDTS 220 kV line to carry a much higher current in its white phase. Immediately after the line auto-reclosed the neutral to earth currents on the MKPS and BOPS generator transformers reappeared with increasing magnitude.

Refer to Figure 2 for an overview of MBTS and the connections to DDTS, MKPS and BOPS immediately after the fault on the No.1 DDTS to MBTS 220 kV line.

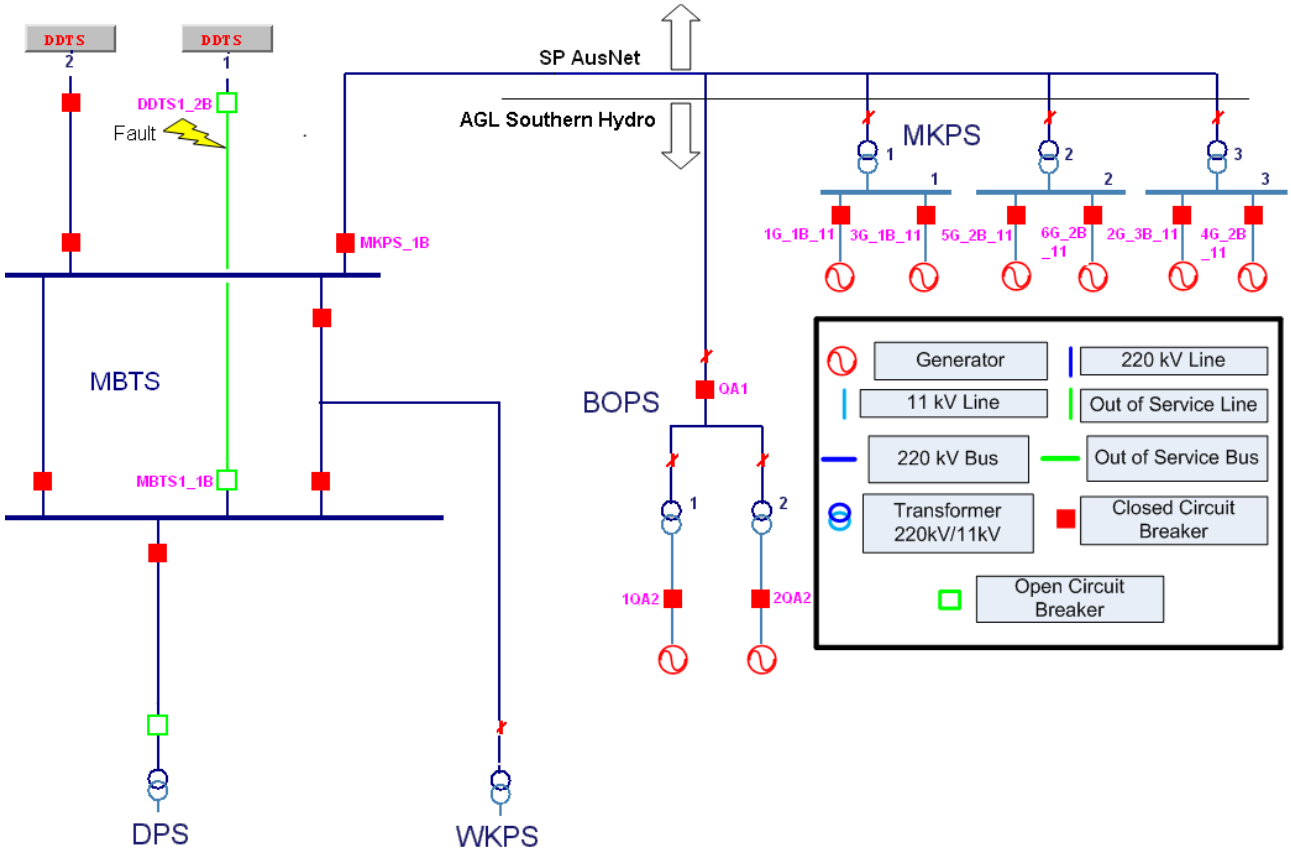

Figure 2 – Network in the vicinity of SP AusNet's MBTS switchyard and AGL's MKPS and BOPS immediately after the fault

The increasing earth fault current was seen by a common earth fault protection relay installed on the MKPS No.1 and No.2 generator transformers, which sent a protection inter-trip to BOPS and MBTS after a set time delay. The MBTS to MKPS tee BOPS 220 kV line tripped on receiving this intertrip, interrupting 197 MW of generation at MKPS and BOPS. Refer to Figure 3 for an overview of MBTS and the connections to DDTS, MKPS and BOPS immediately after the trip of MBTS to MKPS tee BOPS 220 kV line.

[1] See National Electricity Rules S5.1a.8

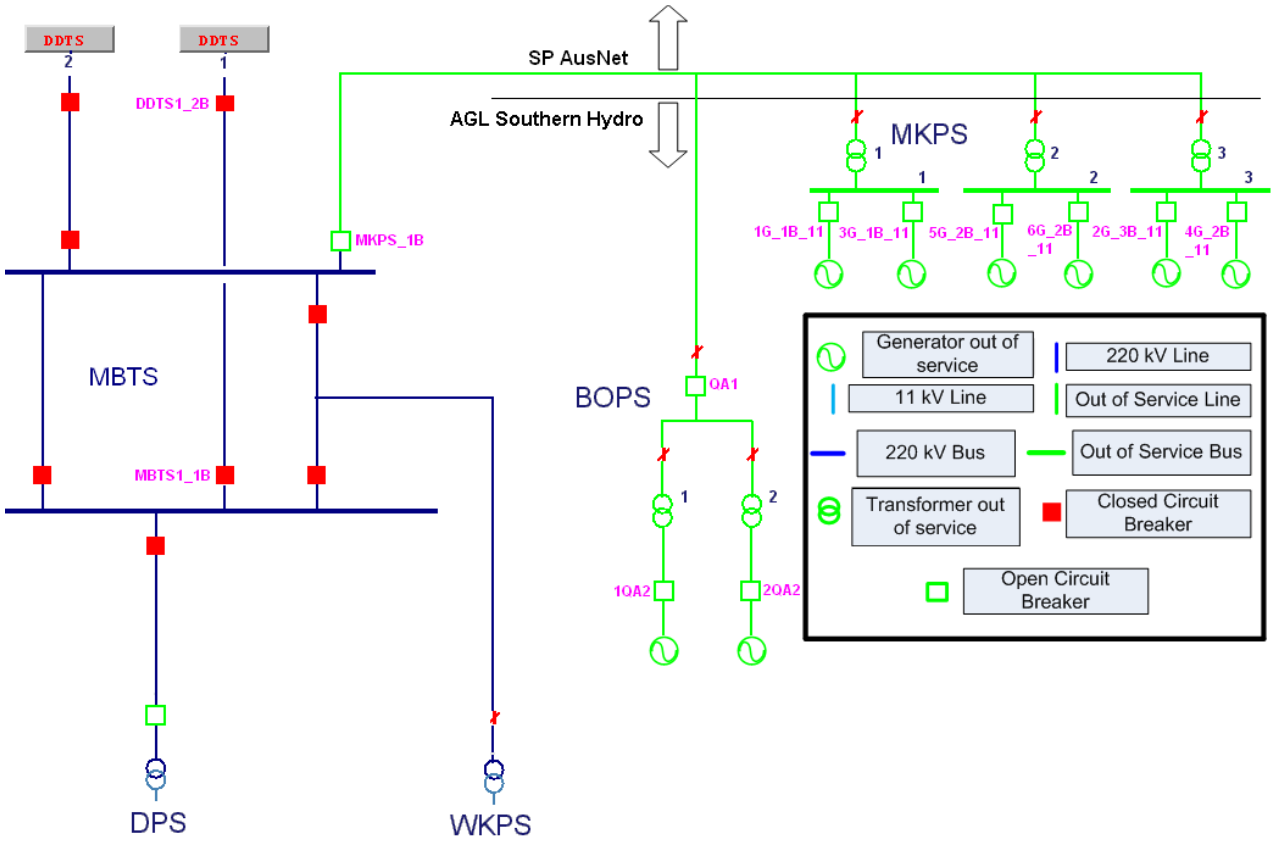

Figure 3 – Network in the vicinity of SP AusNet's MBTS switchyard and AGL's MKPS and BOPS immediately after the trip of MBTS to MKPS tee BOPS 220 kV line

3 Follow-up Actions

At 1341 hrs, SP AusNet manually de-energised the No.1 MBTS to DDTS 220 kV line after observing no power flow on its white phase.

AEMO invoked two constraint sets, both effective in Dispatch from dispatch interval ending 1350 hrs:

- The constraint set V-DDMB for the outage of a DDTS to MBTS 220 kV line was invoked at 1342 hrs
- The constraint set V-MBMK for the outage of the MBTS to MKPS tee BOPS 220 kV line was invoked at 1341 hrs

None of the constraint equations within those invoked constraint sets bound in Dispatch and so did not affect market outcomes over the period concerned.

At 1537 hrs AEMO issued Market Notice No. 34209 to notify participants of the incident.

At 1907 hrs, SP AusNet returned the MBTS to MKPS tee BOPS 220 kV line to service following AGL's initial investigations and the removal of the redundant MKPS No.1 and 2 generator transformer earth fault protection that had sent intertrips to MBTS and BOPS. At 1931 hrs AEMO revoked the relevant constraint set V-MBMK.

After SP AusNet repaired the broken conductor on the No.1 MBTS to DDTS 220 kV line, the line was returned to service at 0042 hrs on 25 January 2011, and at 0051 hrs AEMO revoked the relevant constraint set V-DDMB. The repair work rectified the earth fault on the line in addition to reconnecting the white phase of the No.1 MBTS to DDTS 220 kV line. There was no evidence of earth fault currents after the line was returned to service.

4 Power System Security Assessment

The power system remained in a secure operating state for the duration of the incident.

Power system frequency remained within the normal operating frequency band during the incident.

A total of 197 MW of generation at MKPS and BOPS was interrupted as a result of the line trips.

SP AusNet reported to AEMO that there had been a hot spot on the white phase conductor of the No.1 DDTS to MBTS 220 kV line at the DDTS end. Disturbance recorder data recordings showed the presence of earth fault currents on this line before the fault developed into a two phase to earth fault. When the DDTS to MBTS 220 kV line tripped the neutral to earth currents observed on the MKPS and BOPS generator transformers also reduced. Given that the neutral to earth currents on the MKPS and BOPS generator transformers have not reappeared since the DDTS to MBTS 220 kV line was repaired and returned to service, it can be inferred that the repairs also rectified that issue.

The redundant earth fault protection at MKPS should not have operated for the earth fault on the No.1 DDTS to MBTS 220 kV line. Investigations by AGL found that the protection that sent intertrips to BOPS and MBTS should have been removed from service after commissioning of the more suitable earth fault protection installed as part of the MKPS No.3 generator transformer installation. However AGL had inadvertently left this old protection relay element in service.

5 Conclusions

At 1337 hrs on 24 January 2011 the No.1 MBTS to DDTS 220 kV line tripped following detection of a white to blue phase fault close to the DDTS end and the line auto-reclosed successfully. The white phase conductor of the No.1 MBTS to DDTS 220 kV line had broken at the DDTS end due to a hot spot which quickly developed into a significant fault.

A redundant earth fault protection relay at MKPS incorrectly sent a protection intertrip to BOPS and MBTS, resulting in the trip of the MBTS to MKPS tee BOPS 220 kV line and the interruption of 197 MW of generation at MKPS and BOPS. AGL has since removed this protection relay element from service.

6 Recommendations

1. In light of this incident AGL will review its procedure for change management of protection systems and their settings. AGL will complete this action and report the outcomes to AEMO by the end of July 2011.
2. SP AusNet in conjunction with AEMO Transmission Services will review the adequacy of protection systems and settings on the No.1 and 2 MBTS to DDTS 220 kV lines, to ensure reliable and dependable operation in the presence of high impedance earth faults before such faults develop into significant failures. SP AusNet will inform the outcome of this review to AEMO by the end of July 2011.