POWER SYSTEM OPERATING INCIDENT REPORT
TRIP OF MULTIPLE TRANSMISSION LINES ON 30 NOVEMBER 2011

PREPARED BY: Electricity System Operations Planning and Performance

DATE: 27 March 2012

FINAL

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Abbreviations and Symbols

Abbreviation	Term
CB	Circuit Breaker
Hz	Hertz
kV	Kilovolt
MW	Megawatt

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1 Introduction

At 0600 hrs on 30 November 2011, the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line and the Chapel Street-Risdon 110 kV No.1 line in Tasmania simultaneously tripped out of service. The trip of the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line resulted in a combined loss of 43 MW of generation at Cluny and Repulse power stations. No customer load was interrupted as a result of this incident. Lightning activity was reported in the area at the time.

This report has been prepared under clause 4.8.15 (c) 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.

This report is largely based upon information provided by Transend. Data from AEMO's Energy Management System and Electricity Market Management System has also been used in analysing the incident.

All references to time in this report are to National Electricity Market time (Australian Eastern Standard Time).

2 Pre-Contingent System Conditions

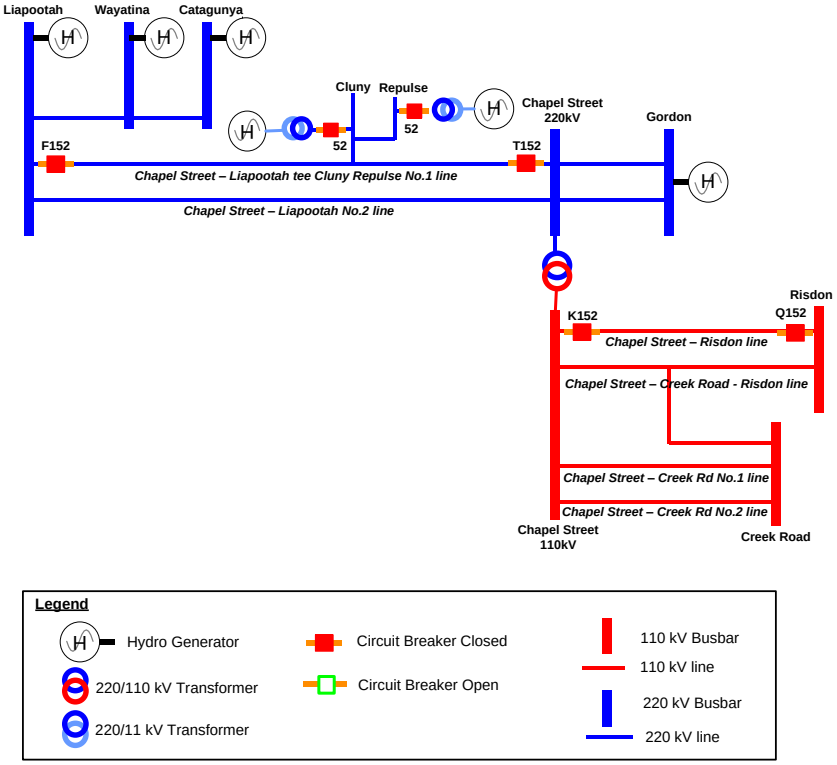
Prior to the incident, AEMO had reclassified the simultaneous trip of the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line and the Chapel Street – Liapootah 220 kV No.2 lines as a credible contingency event. At 0345 hrs AEMO invoked the constraint set T-CSLI_N-2[1] to reflect the reclassification and issued Market Notice No.36815 at 0350 hrs. The reclassification was based on advice from Transend that a lightning storm was present in the area at the time.

AEMO cancelled the reclassification and revoked constraint set T-CSLI_N-2 at 0547 hrs. Refer to Market Notice No.36825 issued at 0552 hrs.

The status of the power system prior to the incident is shown in Figure 1. For clarity only equipment relevant to this incident has been included in the diagram.

[1] Constraint set to avoid voltage instability and line overloads for the loss of both Liapootah to Chapel Street 220 kV lines.

Figure 1 – Network topology prior to the incident



3 Summary of Events

At a time of lightning activity on 30 November 2011, a one phase to earth fault occurred on the blue phase of the Chapel Street-Risdon 110 kV No.1 line resulting in a three phase trip[2] by opening CB Q152 at Risdon and CB K152 at Chapel Street.The line did not auto-reclose following the trip since the auto-reclose function was disabled, which is the normal mode of operation for the line. Line protection systems cleared the fault and the line was returned to service at 0607 hrs.

Coincident with this trip, the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line tripped due to protection system operation. This was initiated following detection of a one phase to earth fault on the blue phase of the line resulting in opening the blue phase of CB T152 at Chapel Street and CB F152 at Liapootah[3]. Following CB operation, auto-reclose of the blue phase was initiated by the protection relays. However, the blue phase only reclosed at the Liapootah end and the Chapel Street end remained open due to protection maloperation. The failure of blue phase to auto-reclose at Chapel Street resulted in a three phase trip (opening the CBs for the remaining two phases) and lock out of the auto-reclose at that end. The distance to the fault was measured by the protection relays at Chapel Street to be approximately 20.4 km from Chapel Street and approximately 63.5 km from Liapootah. The line was returned to service at 0601 hrs.

The key events that took place during the incident are summarised in Table 1 below:

[2] The 110 kV lines in Tasmania are not equipped with high speed single phase protection, thus resulting in three phase trips for single phase faults.
[3] The 220 kV lines in Tasmania are equipped with high-speed single phase protection.

Table 1: Summary of events

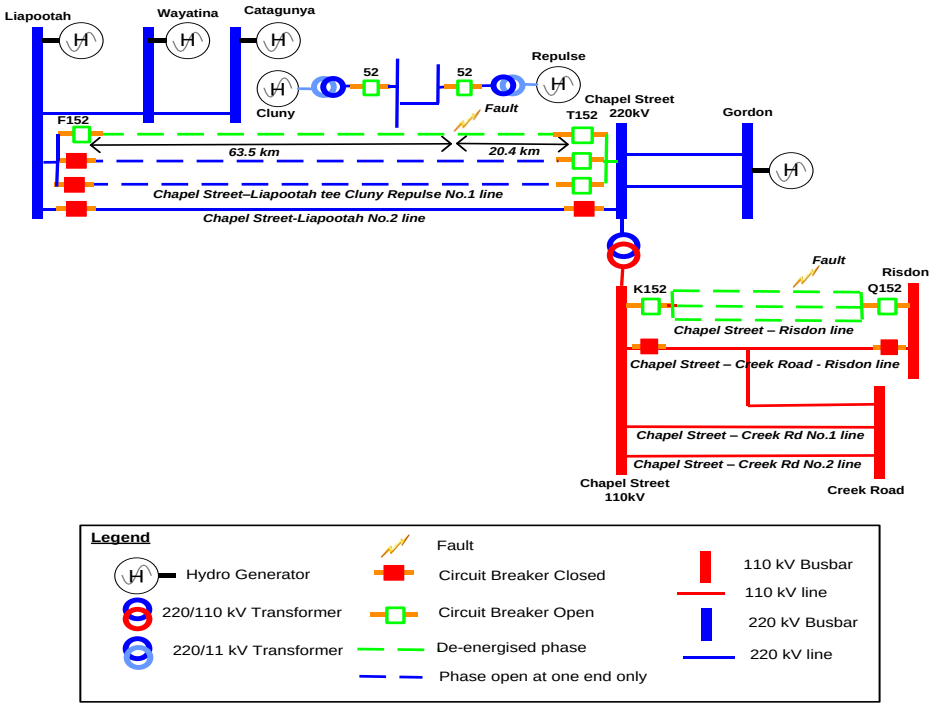
Time	Operation	Comment
6:00:28.047	Blue phase CB open at Chapel Street 220 kV.	Blue phase of Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line de-energised.
6:00:28.067	Blue phase CB open at Liapootah 220 kV.	
6:00:28.120	CB T152 at Chapel Street 110 kV and CB F152 at Risdon 110 kV open.	3 phase trip of the Chapel Street-Risdon 110 kV No.1 line.
6:00:28.137	Red and White Phase CBs open at Chapel Street 220 kV.	Red and White phase of Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line opened at Chapel Street 220 kV. This resulted in all 3 phases of Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line being open at Chapel Street, and the blue phase being open, and the red and white phases being closed at the Liapootah end.
6:00:28.907	Blue phase CB auto-reclose at Liapootah 220 kV. The blue phase CB failed to auto-reclose at Chapel Street 220 kV.	Blue phase of Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line energised from Liapootah end only.
6:01:44.300	CBs for all 3 phases manually reclosed at Chapel Street 220 kV.	All 3 phases of Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line restored to service.
6:07:46.00	CB K152 at Chapel Street 110 kV and CB Q152 at Risdon 110 kV manually reclosed.	Chapel Street-Risdon 110 kV No.1 line restored to service.

The trip of the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line resulted in a loss of 43 MW of generation from Cluny and Repulse power stations. Cluny power station was generating 15 MW and Repulse power station was generating 28 MW respectively at the time.

Cluny and Repulse power stations returned to service at 0608 and 0622 hrs respectively.

The status of the power system immediately after the incident is shown in Figure 2.

Figure 2 – Network topology following the incident



4 Immediate Actions Taken

Following the incident, AEMO discussed the simultaneous trip of the two lines with Transend. Transend advised that they had not yet identified the cause and could not rule out the possibility of the two lines tripping again. Based on this advice AEMO determined, in accordance with its operating procedure SO_OP 3715 Power System Security Guidelines[4], that it was appropriate to reclassify the simultaneous trip of these lines as a credible contingency event.

At 0727 hrs AEMO issued Market Notice No.36834 to advise of this incident as a non credible contingency event and to reclassify the simultaneous trip of these lines as a credible contingency event from 0600 hrs until further notice.

5 Follow-up Actions

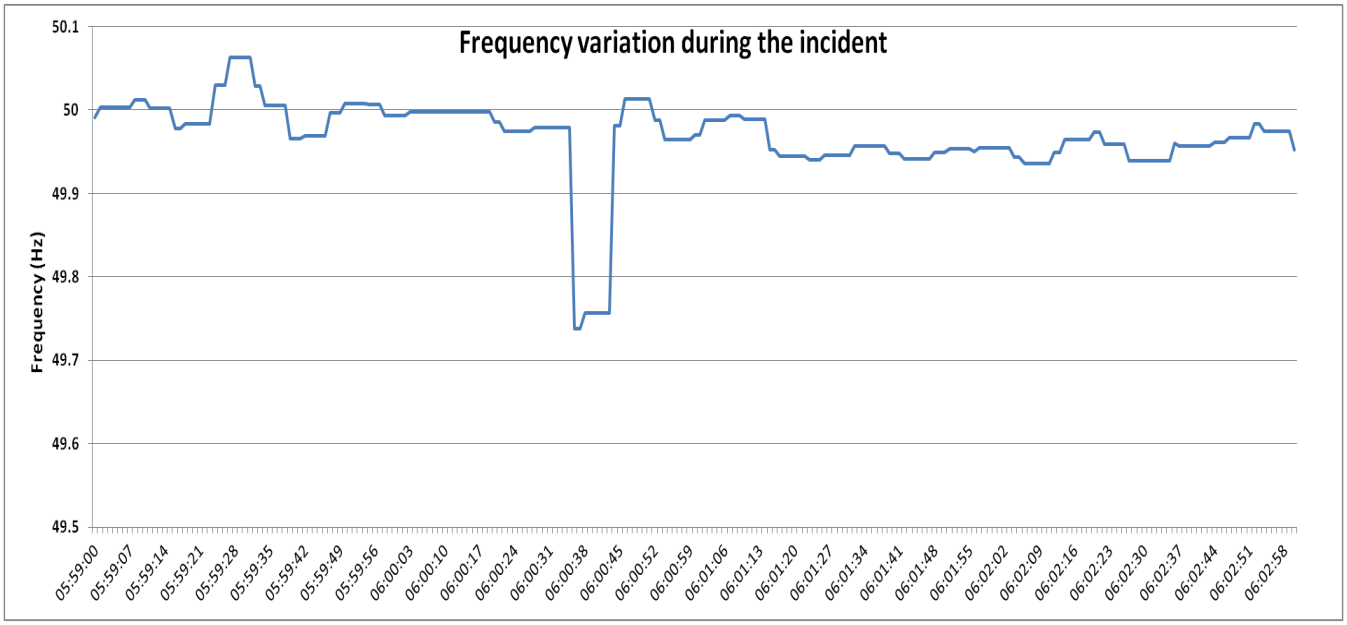
Following the incident Transend checked the protection relays and protection relay logs at the Liapootah and Chapel Street substations and confirmed that the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line experienced a blue phase to earth fault. Transend also confirmed that single phase auto-reclose was only successful at the Liapootah end and the Chapel Street end remained open.

6 Power System Security Assessment

The Tasmanian frequency dropped to 49.73 Hz, below the normal operating band of 49.85 Hz – 50.15 Hz as a result of the incident. However, the frequency was well within the Tasmanian frequency operating standard of 47 Hz – 52 Hz for a multiple contingency event. The frequency returned to the normal operating band within 9 seconds.

The power system frequency variation in Tasmania is shown in Figure 3.

Figure 3 – Power system frequency operation in Tasmania



[4] Clause 4.2.3B of the NER requires that AEMO establish criteria to use when considering whether a non-credible contingency event is reasonably possible. This is published in AEMO operating procedure SO_OP3715 Power System Security Guidelines, which is available at: http://www.aemo.com.au/electricityops/3715.html

The power system voltages and power flows remained within normal operating limits during the incident.

Chapel Street-Risdon 110 kV No.1 line:

The analysis of the relay logs at Risdon and Chapel Street confirmed the fault was cleared by the operation of phase comparison protection[5].The protections operated correctly, with the phase comparison protection being more sensitive and responding faster than the distance protection. However, the relay logs obtained from Chapel Street and Risdon substations were found to be missing some information about the protection operations during the incident, which are otherwise recorded during such incidents. The trip logs obtained from Chapel Street and Risdon substations also had incorrect time stamping on them which made fault investigation difficult. Transend confirmed the clock at Risdon substation had failed which caused the incorrect time stamping at the Risdon end. The reason for the incorrect time stamping at the Chapel Street end is yet to be determined.

Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line:

The analysis of the relay logs confirmed the fault was cleared by the operation of distance protection which operated correctly. Using the available fault data, the fault was determined to be within Zone 1 of the Chapel Street relay and Zone 2 of the Liapootah relay. The Chapel Street relay tripped the blue phase of CB T152 at Chapel Street and initiated permissive signalling[6] to trip the blue phase of CB F152 at Liapootah. The failure of the blue phase to auto-reclose at the Chapel Street end was due to the maloperation of a bay controller which disabled single phase auto-reclose. This resulted in tripping of all three phases of the line at the Chapel Street end without auto-reclose (lock-out).

The provision and response of facilities and services were adequate to maintain power system security.

7 Conclusions

At 0600 hrs on 30 November 2011, the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line and Chapel Street-Risdon 110 kV No.1 line tripped on protection operation to clear earth faults due to lightning strikes. The trip resulted in a combined loss of 43 MW of generation at Cluny and Repulse power stations, but no loss of customer load.

The facilities provided to manage the one phase to earth faults on the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 and Chapel Street-Risdon 110 kV No.1 lines were adequate for the conditions experienced at the time.

AEMO correctly applied the criteria published in Section 12 of its Power System Security Guidelines in assessing the reclassification of the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 and Chapel Street-Risdon 110 kV No.1 lines as a credible contingency event.

However, AEMO concludes that maloperation of the auto-reclose on the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line was the principal cause for this simultaneous trip incident.

8 Recommendations

AEMO recommends that Transend take adequate actions to mitigate the risk of similar incidents occurring in future, and proposes the following:

[5] Phase comparison protection systems operate by comparing the phase angles of currents entering at one terminal of the line and the currents leaving at the other terminal of the line.
[6] Permissive schemes allow distance protection relays to initiate accelerated tripping of CBs at the remote end of the line (away from fault), provided the remote relay has seen the fault and receives a “permissive signal” from the relay at the near end of the line (close to the fault).

1. Transend to investigate and conduct site testing to resolve the auto-reclose logic issue in the bay controller that disabled the single phase auto-reclose of the Chapel Street-Liapootah tee Repulse Cluny 220 kV No.1 line, by 30 April 2012.
2. Transend to investigate the cause for the missing relay log information at Chapel Street and Risdon subtations, by 30 September 2012.
3. Transend to repair the relay time stamping at both Risdon and Chapel Street 110 kV protection devices, by 30 September 2012.