POWER SYSTEM OPERATING INCIDENT REPORT
SIMULTANEOUS TRIP OF 71 MT PIPER – WALLERAWANG 330 KV LINE AND MT PIPER NO.1 UNIT ON 13 FEBRUARY 2012

PREPARED BY: Electricity System Operations Planning and Performance

DATE: 7 June 2012

FINAL

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Abbreviations and Symbols

Abbreviation	Term
CB	Circuit breaker
Hz	Hertz
kV	Kilovolt
MW	Megawatt
ms	Millisecond

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1 Introduction

At 1419 hrs on 13 February 2012, the 71 Mt Piper – Wallerawang 330 kV line and the No.1 generating unit and its transformer group[1] at Mt Piper power station in New South Wales simultaneously tripped out of service. Lightning activity was reported in the vicinity of Mt Piper power station at the time. Mt Piper No.1 generating unit was generating 595 MW prior to the incident.

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.

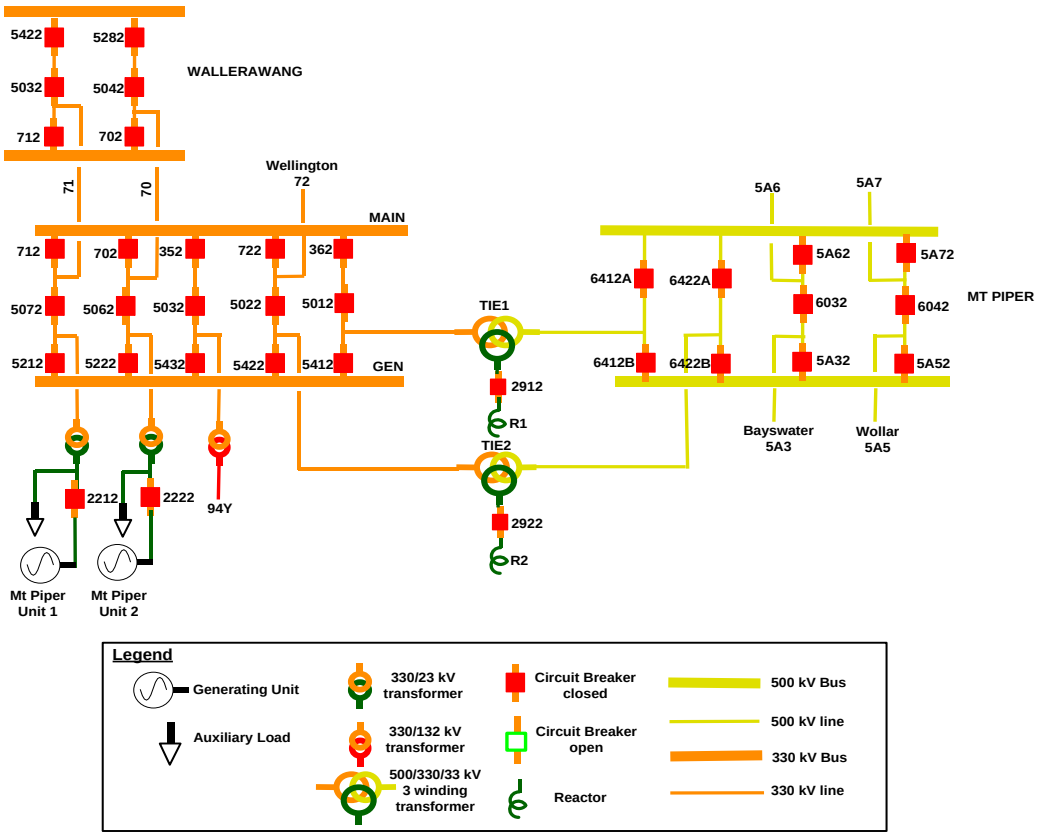
This report is largely based upon information provided by TRUenergy, Delta Electricity and TransGrid. Data from AEMO's Energy Management System and Electricity Market Management System has also been used in analysing the incident.

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

2 Pre-Contingent System Conditions

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.

Figure 1 – Network topology prior to the incident



[1] The No.1 generator transformer group consists of two 330/23 kV generator transformers, two 23/11 kV auxiliary transformers and a 23 kV/1 kV/110 V excitation transformer.

3 Summary of Events

At a time of lightning activity on 13 February 2012, a one phase to ground fault occurred on the blue phase of the 71 Mt Piper – Wallerawang 330 kV transmission line resulting in a three phase trip of the line. Zone 1 distance protection at Mt Piper 330 kV substation detected the fault and tripped circuit breakers (CBs) 712 and 5072 at Mt Piper. Accelerated Zone 2 distance protection at Wallerawang 330 kV substation detected the fault and tripped CBs 712 and 5032 at Wallerawang. The fault was cleared within 60 ms from the Mt Piper end and 90 ms from the Wallerawang end. The fault was cleared within the required fault clearance times specified in the NER.

Coincident with the 71 line trip, the Mt Piper No.1 generator CB 2212 and Mt Piper No.1 unit 11 kV auxiliary CBs (not shown in diagrams) opened, disconnecting the Mt Piper No.1 generating unit from the power system. Approximately 158 milliseconds after the generating unit trip, Mt Piper No.1 generator transformer 330 kV CB 5212 opened disconnecting the generator transformer group from the power system.

The 71 line 330 kV CBs at Mt Piper and Wallerawang auto-reclosed within 16 seconds of the trip. Consistent with the design of the protection system, CB 5072 at Mt Piper did not auto-reclose. It was manually closed at 1529 hrs when the Mt Piper No.1 generator transformer was returned to service. The protection systems were unable to estimate the distance to fault accurately but the fault location was determined to be very close to the Mt Piper end of the 71 line.

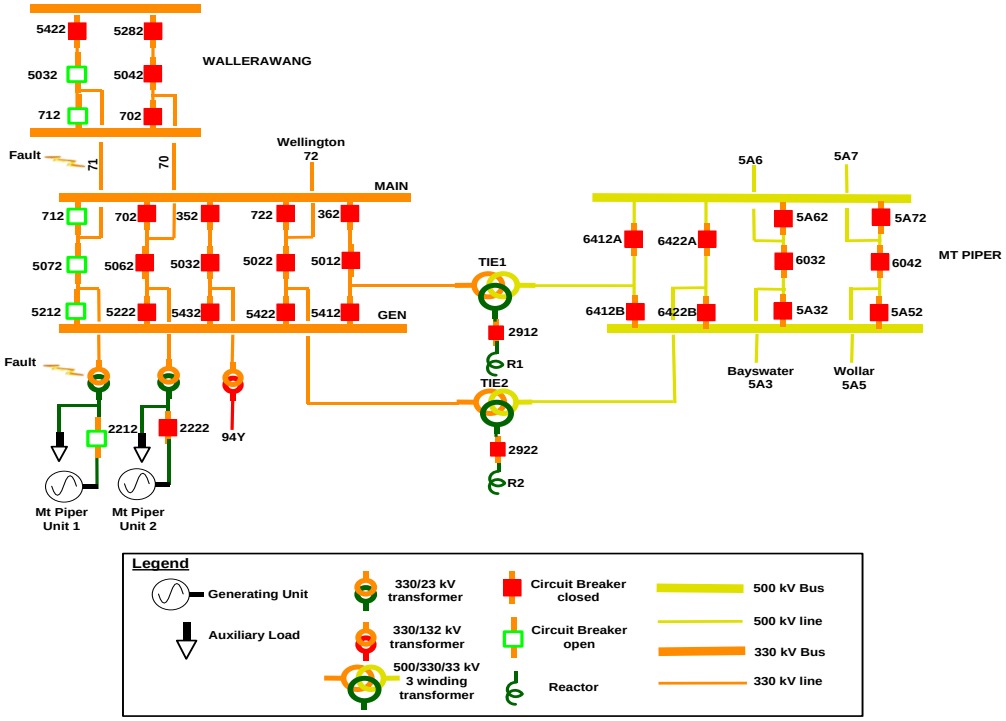
The key events that took place during the incident are summarised in Table 1 below:

Table 1: Summary of events

Time	Event	Comments
13/02/2012 14:19:11	Mt Piper 330 kV CB 712 open.	71 Mt Piper – Wallerawang 330 kV line tripped.
13/02/2012 14:19:11	Mt Piper 330 kV CB 5072 open.	
13/02/2012 14:19:11	Wallerawang 330 kV CB 712 open.	
13/02/2012 14:19:11	Wallerawang 330 kV CB 5032 open.	
13/02/2012 14:19:11	Mt Piper No.1 generator CB 2212 open.	Mt Piper No.1 generating unit and auxiliaries disconnected from power system.
13/02/2012 14:19:11.2	Mt Piper No.1 generator transformer 330 kV CB 5212 open.	Mt Piper No.1 generator transformer group disconnected from power system.
13/02/2012 14:19:27	Mt Piper 330 kV CB 712 auto-reclose.	71 Mt Piper – Wallerawang 330 kV line returned to service.
13/02/2012 14:19:27	Wallerawang 330 kV CB 712 auto-reclose.	
13/02/2012 14:23:22	Mt Piper 330 kV CB 5032 manual close.	
13/02/2012 15:28:51	Mt Piper 330 kV CB 5212 manual close.	Mt Piper No.1 generator transformer group returned to service.
13/02/2012 15:29:10	Mt Piper 330 kV CB 5072 manual close.	
14/02/2012 01:30:00	Mt Piper No.1 generator CB 2212 closed.	Mt Piper No.1 generating unit returned to service.

The status of the power system immediately following the trip of the 71 line and Mt Piper No.1 generating unit is shown below.

Figure 2 – Network topology following the trip of 71 line and Mt Piper No.1 generating unit



4 Immediate Actions Taken

Following the incident, TransGrid personnel were sent to the Mt Piper switchyard to investigate. TransGrid advised AEMO that protection system logs indicated correct operation for a lightning strike on the 71 line.

TransGrid and Delta Electricity investigated the cause of the simultaneous trip of the 71 line with the Mt Piper No.1 generating unit and generator transformer group. Pending further advice from TransGrid and Delta Electricity, AEMO determined, in accordance with section 12 of its Power System Security Guidelines[2], to reclassify the simultaneous trip of 71 Mt Piper – Wallerawang 330 kV line and Mt Piper No.1 generating unit as a credible contingency event from 1430 hours on 13 February 2012 until further notice. At 1449 hrs and 1452 hrs on that day AEMO issued Electricity Market Notice Nos. 37779 and 37780 respectively to advise this to market participants.

5 Follow-up Actions

TransGrid informed AEMO that the Mt Piper No.1 generator transformer 330 kV CB 5212 tripped due to an intertrip signal received from Mt Piper unit protection systems.

Delta Electricity conducted a detailed investigation of the simultaneous trip of the 71 line with the Mt Piper No.1 generating unit . Delta Electricity investigations revealed that the trip of the No.1 generating unit and generator transformer group was initiated by the Mt Piper No.1 unit protection systems. Delta Electricity found that one of the generator transformers in the Mt Piper No.1

[2] 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

generator transformer group had been subjected to repeated lightning strikes with high intensity. This caused repeated oil surges within the main tank, diverter switch and tap changer compartments of the transformer. The oil surges triggered the operation of Buchholz[3] protection of the transformer, which sent a trip signal to the Mt Piper No.1 unit protection systems, thereby causing the trip of the 22 kV generator CB 2212, generator transformer CB 5212 and some 11 kV auxiliary CBs (not shown in the diagrams).

Delta Electricity also confirmed that lightning arrestors at the Mt Piper power station showed visible arcing marks indicating the impact of lightning strikes.

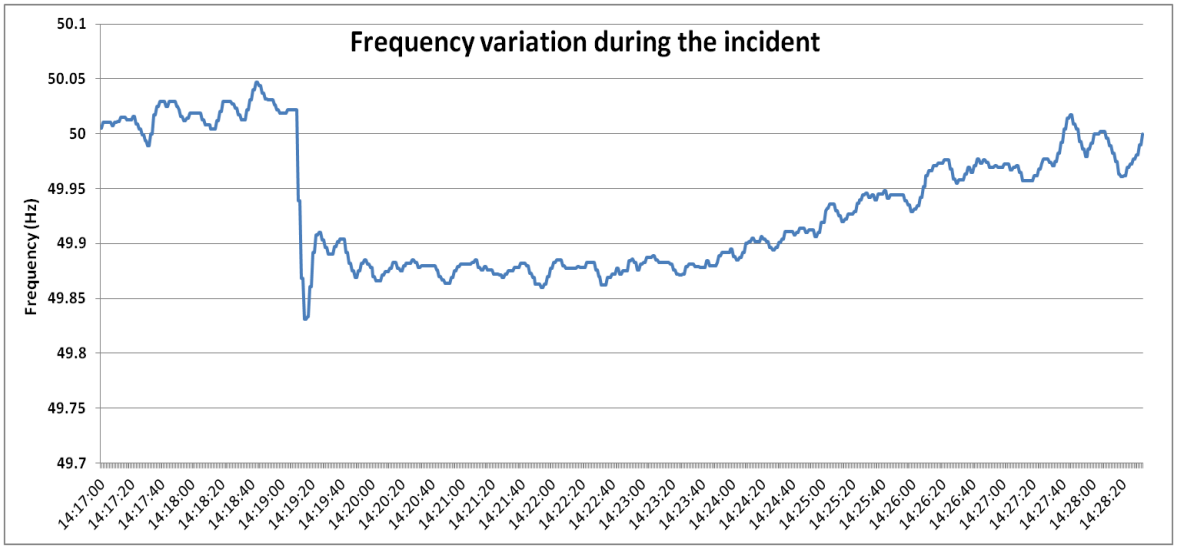
In April 2012, Delta Electricity arranged for an outage of the Mt Piper No.1 generating unit specifically to inspect and test the affected transformer. As a result of that inspection and testing, the transformer has since been replaced by an available spare transformer which is currently in operation.

The reclassification of simultaneous trip of 71 Mt Piper – Wallerawang 330 kV line and Mt Piper No.1 generating unit as a credible contingency event is still current. AEMO will consult TransGrid and Delta Electricity to determine when this contingency reclassification can be cancelled.

6 Power System Security Assessment

As a result of the incident, the mainland power system frequency dropped to 49.83 Hz, below the normal operating band of 49.85 Hz – 50.15 Hz. However, the frequency was well within the mainland frequency operating standard of 49.5 Hz – 50.5 Hz for a generation event. The frequency returned to the normal operating band (49.85 Hz – 50.15 Hz) within 4 seconds. The power system frequency variation in the mainland is shown in Figure 3 below.

Figure 3 – Frequency variation during the incident



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

The provision and response of facilities and services by Delta Electricity, TransGrid and AEMO were adequate to maintain power system security.

[3] The Buchholz relay (used in transformer protection), is a widely used gas and oil surge relay that provides protection against most transformer internal faults.

7 Conclusions

At 1419 hrs on 13 February 2012, the 71 Mt Piper – Wallerawang 330 kV line tripped to clear a one phase to ground fault attributed to lightning strikes experienced in the vicinity of the power station. Coincident with the 71 line trip, Mt Piper No.1 generating unit, its auxiliary supplies and its generator transformer group tripped out of service. The trip of the generating unit, its auxiliary supplies and generator transformer group was initiated by the generator transformer protections when one of the generator transformers experienced oil surges, believed to have been caused by repeated high intensity lightning strikes. This incident resulted in the loss of 595 MW of generation.

All affected equipment was returned to service by 0130 hrs on 14 February 2012.

The facilities and services provided to manage the simultaneous trip of the 71 line, Mt Piper No.1 generating unit, its auxiliary supplies and generator transformer group 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 71 Mt Piper – Wallerawang 330 kV line and Mt Piper No.1 generating unit as a credible contingency event.

8 Recommendations

AEMO in consultation with TransGrid and Delta Electricity will determine when the reclassification of the simultaneous trip of the 71 Mt Piper – Wallerawang 330 kV line and Mt Piper No.1 generating unit as a credible contingency event can be cancelled. This action will be completed by mid June 2012.