POWER SYSTEM OPERATING INCIDENT REPORT
SIMULTANEOUS TRIP OF 5A6 MT PIPER – BANNABY 500 KV LINE AND MT PIPER NO. 2 UNIT ON 9 FEBRUARY 2012

PREPARED BY: Electricity System Operations Planning and Performance

DATE: 5 June 2012

FINAL

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Abbreviations and Symbols

Abbreviation	Term
CB	Circuit Breaker
kV	Kilovolt
MW	Megawatt
ms	Millisecond
NER	National Electricity Rules

1 Introduction

At 2216 hrs on 9 February 2012, the 5A6 Mt Piper – Bannaby 500 kV line and the No.2 generating unit at Mt Piper power station in New South Wales simultaneously tripped out of service. The unit trip also resulted in the loss of station auxiliary supply to the Mt Piper switchyard. Lightning activity was reported in the vicinity of 5A6 line at the time.

Shortly after, the 330 kV circuit breakers (CBs) of the Mt Piper No.2 generator transformer group[1] opened, de-energising the generator transformers, auxiliary transformers and excitation transformer.

Mt Piper Unit 2 was generating 342 MW prior to the incident.

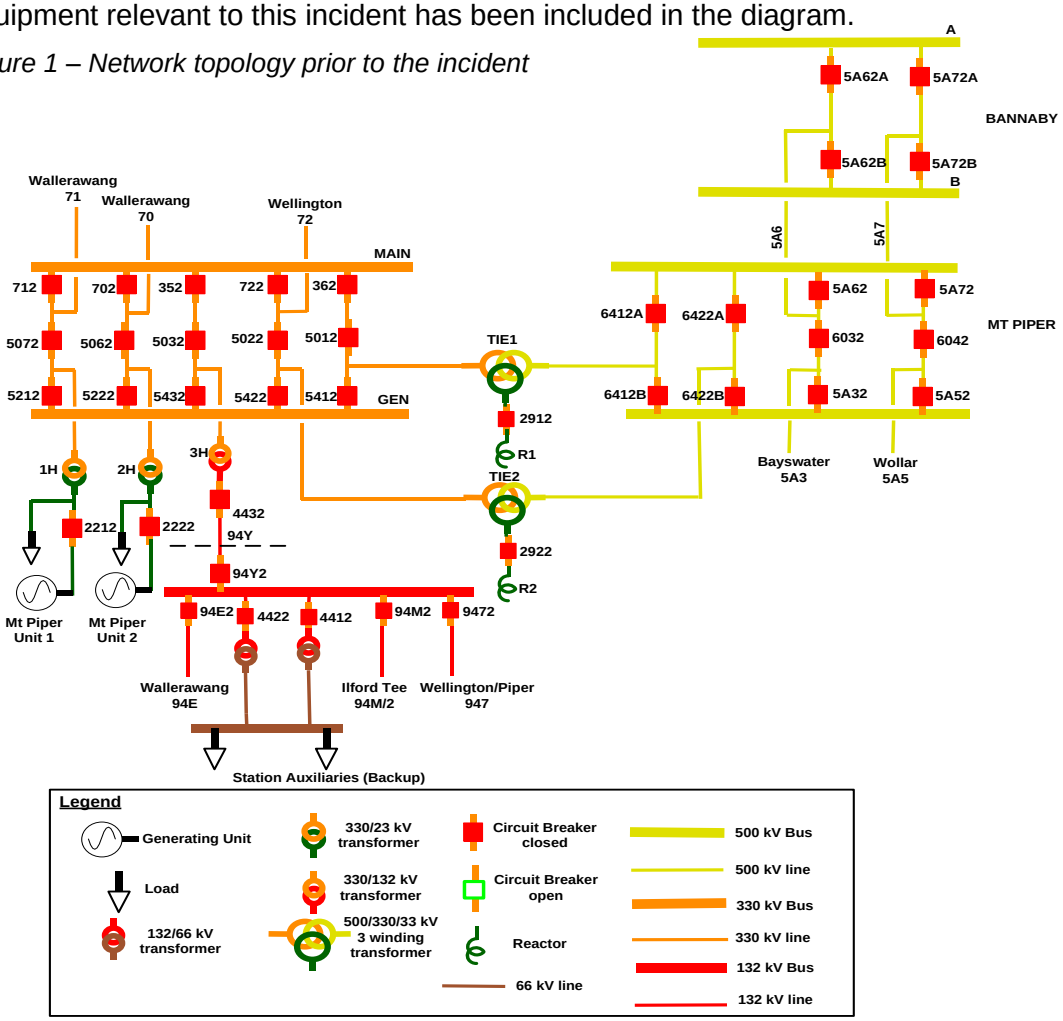
This report has been prepared under clause 4.8.15 (c) of the National Electricity Rules to assess the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security.

This report is largely based upon information provided by TRUenergy/Delta Electricity (Mt Piper power station) 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.2 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.

The auxiliary supply to the Mt Piper 500 kV switchyard (including tie transformers), as per current operating arrangements, is supplied through the Mt Piper No.1/2 unit 11 kV switchboard. TransGrid had not advised this special auxiliary supply arrangement to AEMO prior to this incident. At the time of the incident, the Mt Piper Station 11 kV switchboard was operated such that there was an open point between the Unit 1 and 2 supply to the switchboard.

3 Summary of Events

At a time of lightning activity on 9 February 2012, a one phase to ground fault occurred on the red phase of the 5A6 Mt Piper – Bannaby 500 kV transmission line resulting in a three phase trip of the line. Zone 1 distance protection at Bannaby 500 kV substation detected the fault and tripped CBs 5A62A and 5A62B at Bannaby. Zone 1 distance protection at Mt Piper 500 kV substation detected the fault and tripped CBs 5A62 and 6032 at Mt Piper. The fault was cleared within 52 ms from the Mt Piper end and 62 ms from the Bannaby end. The fault was cleared within the required fault clearance times specified in the NER. All CBs auto-reclosed within 20 seconds of the trip. The distance to fault measured by the protection relays was approximately 33.19 km from the Mt Piper end.

Coincident with the 5A6 line trip, the Mt Piper No. 2 generator CB 2222 and its 11 kV auxiliary supply CBs (not shown in the diagrams) opened, disconnecting the generating unit from the power system and de-energising all its auxiliary supplies including auxiliary supplies to the Mt Piper switchyard and No.2 generator transformer cooling systems. Approximately 1 minute and 43 seconds later, the Mt Piper No.2 generator transformer 330 kV CBs 5062 and 5222 opened, de-energising the Mt Piper No.2 generator transformer group.

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

Table 1: Summary of events

Time	Event	Comments
09/02/2012 22:16:05	Bannaby 500 kV CB 5A62A open.	5A6 Mt Piper – Bannaby 500 kV line tripped.
09/02/2012 22:16:05	Bannaby 500 kV CB 5A62B open.	
09/02/2012 22:16:05	Mt Piper 500 kV CB 5A62 open.	
09/02/2012 22:16:05	Mt Piper 500 kV CB 6032 open.	
09/02/2012 22:16:05	Mt Piper No. 2 generator CB 2222 open.	Mt Piper No. 2 generating unit, the unit and station auxiliary supplies supplied form the No.2 generating unit disconnected from the power system.
09/02/2012 22:16:21	Bannaby 500 kV CB 5A62B auto-reclose.	5A6 Mt Piper – Bannaby 500 kV line returned to service.
09/02/2012 22:16:23	Bannaby 500 kV CB 5A62A auto-reclose.	
09/02/2012 22:16:23	Mt Piper 500 kV CB 5A62 auto-reclose.	
09/02/2012 22:16:25	Mt Piper 500 kV CB 6032 auto-reclose.	
09/02/2012 22:17:48	Mt Piper 330 kV CB 5062 open.	Mt Piper No. 2 generator transformer group de-energised.

Time	Event	Comments
09/02/2012 22:17:48	Mt Piper 330 kV CB 5222 open.	
09/02/2012 23:41:10	Mt Piper 330 kV CB 5062 manual close.	Mt Piper No. 2 generator transformer group returned to service.
09/02/2012 23:41:10	Mt Piper 330 kV CB 5222 manual close.	
10/02/2012 02:17:00	Mt Piper No.2 generator CB 2222 closed.	Mt Piper No.2 generating unit returned to service.

The status of the power system immediately following the trip of the 5A6 line and Mt Piper No.2 generating unit is shown in Figure 2. Figure 3 shows the status of the power system after the subsequent auto-reclose of 5A6 line and de-energisation of the Mt Piper No.2 generator transformer group.

Figure 2 – Network topology immediately following 5A6 line trip and Mt Piper generating unit trip

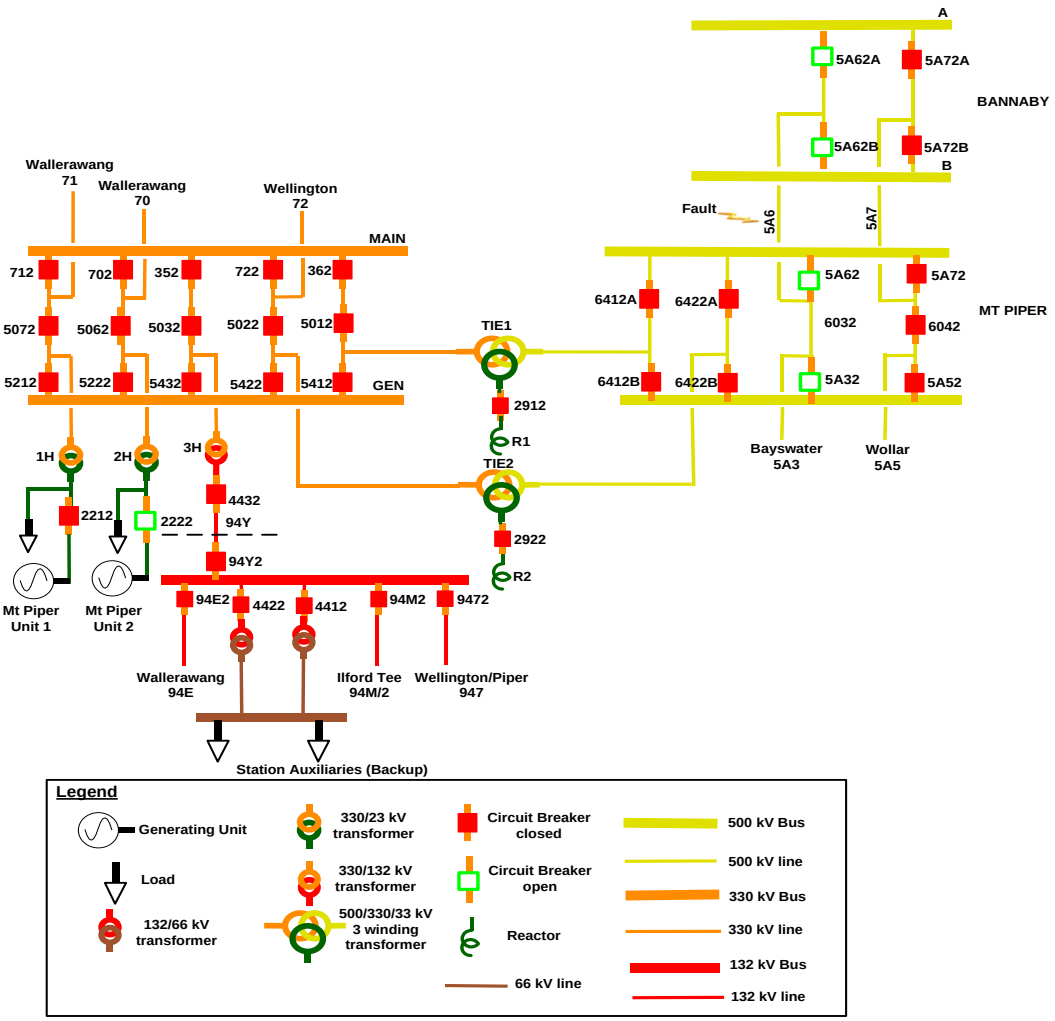
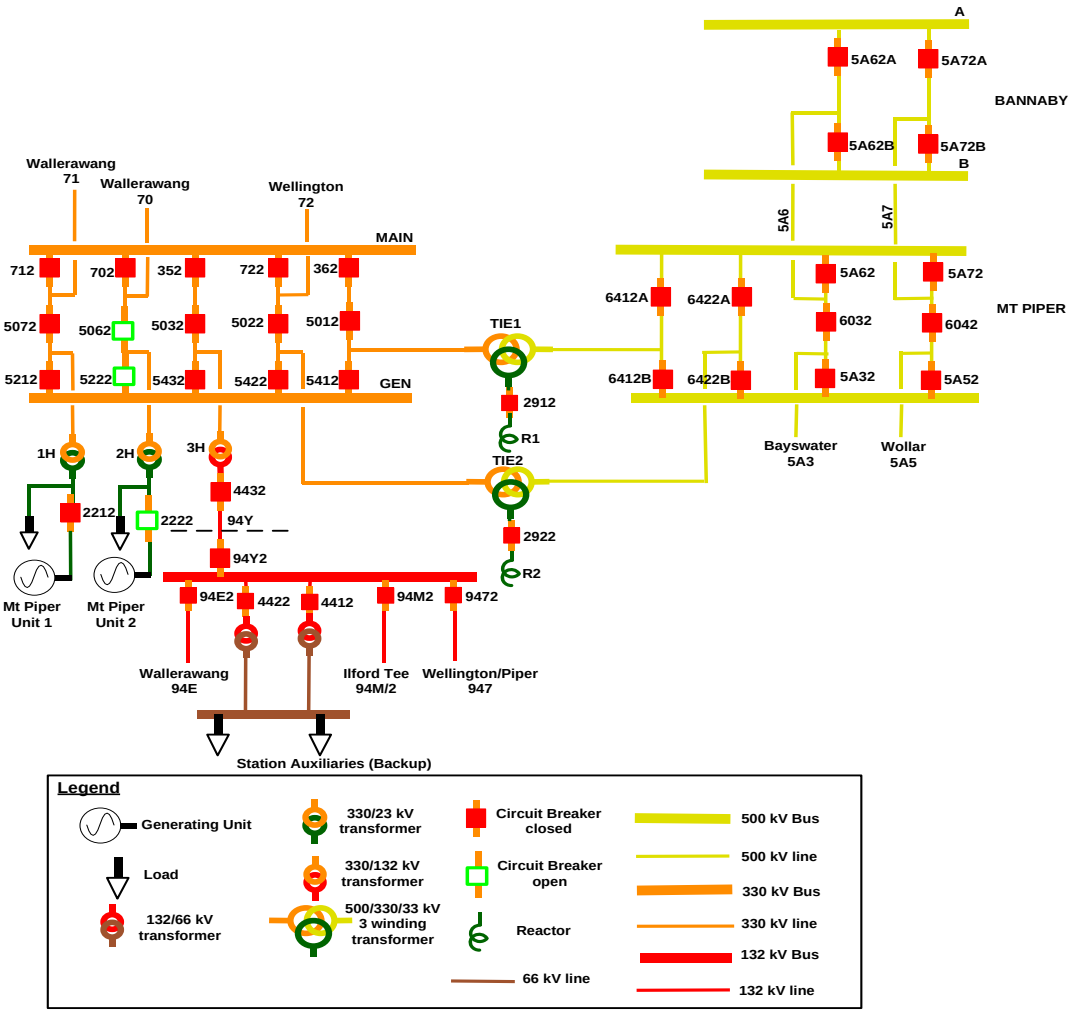


Figure 3 – Network topology after 5A6 line auto-reclosed and Mt Piper generator transformer group de-energised



4 Immediate Actions Taken

At the time of the incident, since the Mt Piper No.2 unit 11 kV supply was the only source out of the three installed sources available to the auxiliaries of the Mt Piper switchyard, the trip of the Mt Piper No.2 generating unit interrupted those supplies. Following the incident,TransGrid personnel were sent to the Mt Piper switchyard to investigate. TransGrid advised AEMO that power supplies to the cooling systems of the Mt Piper TIE1 and TIE2 500/330/33 kV transformers were lost when the No.2 unit tripped and the transformers would need to operate at reduced ratings to avoid post-contingent thermal overload.

Based on the revised thermal ratings received from TransGrid, AEMO derated both TIE1 and TIE2 transformers to 750 MVA each in its Energy Management System.

At 0028 hrs on 10 February 2012, TransGrid informed AEMO that the power supplies to the cooling systems of the TIE1 and TIE2 transformers had been restored. Based on this advice AEMO restored the thermal ratings of both transformers to their normal ratings of 1500 MVA each.

The cause of the simultaneous trip of the Mt Piper No.2 generating unit with the 5A6 line is still being investigated. Pending further advice from TransGrid and Delta Electricity, AEMO determined,

in accordance with its Power System Security Guidelines[2], to reclassify the simultaneous trip of the 5A6 Mt Piper – Bannaby 500 kV line and the Mt Piper No.2 generating unit as a credible contingency event from 1800 hours on 10 February 2012 until further notice. At 1834 hrs that day AEMO issued the Market Notice No.37740 to advise this to market participants.

5 Follow-up Actions

Since the incident, Delta Electricity, TransGrid and AEMO have been working closely to investigate the cause of the simultaneous trip of the Mt Piper No.2 generating unit and its auxiliary supplies with the 5A6 line. The current status of the investigation is:

TransGrid

TransGrid has informed AEMO that no interzone protection[3] operated at the Mt Piper 330 kV switchyard and no intertrip signal was sent to disconnect the Mt Piper No.2 generating unit from the power system.

Delta Electricity

- Mt Piper No.2 generating unit trip: Delta Electricity has informed AEMO that the Mt Piper unit electrical protection system logs recorded the receipt of a signal indicating that TransGrid's interzone protection operated. The source of this signal, however, is still being investigated.
- Mt Piper No.2 generator transformer trip: Delta Electricity has informed AEMO that the subsequent trip of the generator transformer 330 kV CBs is reasoned to have been initiated by the Mt Piper protection systems. The trip of the generating unit and its auxiliary CBs caused the loss of all auxiliary supplies to the unit, including the 415 V main and standby power supplies to the cooling oil pumps of the generator transformers. The flow of oil for cooling is an essential requirement for the generator transformers to remain in service. The loss of oil flow was detected by the transformer protection and, after the set time-out, sent a trip signal to the Mt Piper No.2 generating unit protection system. This protection in turn relayed the signal to the TransGrid interzone protection systems which tripped the Mt Piper No.2 generator transformer 330 kV CBs 5062 and 5222.

TRUenergy

On 30 April 2012, in accordance with clause 4.15 of the National Electricity Rules, TRUenergy submitted a notice of non-compliance with the registered performance standards for Mt Piper No.2 generating unit. This non-compliance is in relation to the capability of the unit to ride-through power system disturbances, particularly for transmission line faults outside their intended protection zone. AEMO has requested TRUenergy to return the unit to compliance by 1 December 2012.

6 Power System Security Assessment

The power system voltages and frequencies remained within the normal operating bands and the power system remained in a secure operating state throughout the incident.

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

[2] Clause 4.2.3B of the National Electricity Rules 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

[3] Interzone protection operates from TransGrid's Mt Piper 330 kV switchyard. A correct operation of interzone protection involves the simultaneous trip of 330 kV CBs 5222 and 5062 and an intertrip signal being sent to Mt Piper No.2 generating unit protection to trip generator CB 2222 and its auxiliary breakers, to disconnect the generating unit from the power system.

7 Conclusions

At 2216 hrs on 9 February 2012, the 5A6 Mt Piper – Bannaby 500 kV line tripped and auto-reclosed to successfully clear a one phase to ground fault caused by lightning strikes. Coincident with the 5A6 line trip, the Mt Piper No.2 generating unit and its auxiliary supplies tripped out of service, resulting in the loss of 342 MW of generation.

All affected equipment was returned to service by 0217 hrs on 10 February 2012.

The trip of the unit auxiliary supplies caused the loss of power to the Mt Piper No.2 generator transformer cooling systems, correctly resulting in the tripping of the generator transformer by intertrip signal from the Mt Piper No.2 generating unit protection.

TransGrid and Delta Electricity are currently investigating the cause of the trip of the Mt Piper No.2 generating unit and its auxiliary supplies.

The facilities and services provided to manage the simultaneous trip of the 5A6 line and the Mt Piper No.2 generating unit, and the subsequent trip of the Mt Piper No.2 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 reclassifying the loss of the 5A6 Mt Piper – Bannaby 500 kV line and the Mt Piper No.2 generating unit as a credible contingency event.

Note that, at 0618 hrs on 6 April 2012, the simultaneous trip incident reoccurred when the Mt Piper No.2 generating unit tripped out of service during a trip and auto-reclose of the 5A6 Mt Piper – Bannaby 500 kV line. Similar to the earlier incident on 9 February 2012, the generator transformer 330 kV circuit breakers opened one minute and 43 seconds later, de-energising the generator transformers. TransGrid informed AEMO that the 5A6 line tripped due to a one phase to ground fault occurring on the red phase of the line. However, this reoccurrence of the incident is not reviewable under clause 4.8.15 of the National Electricity Rules as the simultaneous trip of the 5A6 line and the Mt Piper No.2 generating unit had already been reclassified as a credible contingency event.

8 Recommendations

1. Delta Electricity and TransGrid will inform AEMO of progress with their investigations into the cause of the trip of the Mt Piper No. 2 generating unit, by the end of July 2012.
2. TransGrid to confirm the date that the auxiliary supply to the Mt Piper switchyard will be re-configured to provide the normal supply to the 500 kV switchyard from the 330/132 kV 3H transformer by the end of July 2012.
3. TransGrid must, to the extent that TransGrid is aware or ought reasonably to have been aware, keep AEMO fully and timely informed as to the state of the security of the power system. AEMO will reinforce this requirement at the next Power System Security working group and at the regular operational meeting with the TNSPs. This recommendation to be completed by the end of October 2012.