POWER SYSTEM OPERATING INCIDENT REPORT – MULTIPLE ELEMENT TRIP AT CAPITAL SUBSTATION ON 8 JANUARY 2013

PREPARED BY: System Performance and Commercial

DATE: 6 May 2013

FINAL

Disclaimer

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Abbreviations and Symbols

Abbreviation	Term
CB	Circuit Breaker
EMS	Energy Management System
kV	Kilovolt
ms	Milisecond
MW	Megawatt
NER	National Electricity Rules

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Incident summary

Date and time of incident	8 January 2013 at 1346 hrs
Region of incident	NSW
Affected regions	NSW
Event type	TT – Loss of multiple transmission elements
Primary cause	ENVI & OTHER – Environment and Other
Impact	Significant
Associated reports	NIL

1 Introduction

On 8 January 2013, NSW experienced extreme weather conditions. The day was hot, dry and windy leading to catastrophic fire danger ratings for most of the state. At 1346 hrs on 8 January 2013, the A and C 330 kV Busbars at Capital Substation tripped concurrently with the Canberra – Capital 6 and Capital – Kangaroo Valley 3W 330 kV Transmission Lines. Consequently, the Capital and Woodlawn Wind Farms also tripped, from outputs at approximately 99 MW and 27 MW respectively. The Capital – Kangaroo Valley 3W 330 kV transmission line auto-reclosed onto the B 330 kV busbar at Capital Substation. At 1406 hrs, protection systems operated to again trip the Capital – Kangaroo Valley 3W 330 kV transmission line but it did not auto-reclose and it remained out of service. The total reduction in generation was 126 MW.

There were reports of bushfires in the vicinity of the Capital – Kangaroo Valley 3W 330 kV Transmission Line during this period.

This report has been prepared under clause 4.8.15 (c) of the National Electricity Rules (NER) 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 Transgrid and Infigen Energy. Data from AEMO's Energy Management System (EMS) and Electricity Market Management System (EMMS) 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.

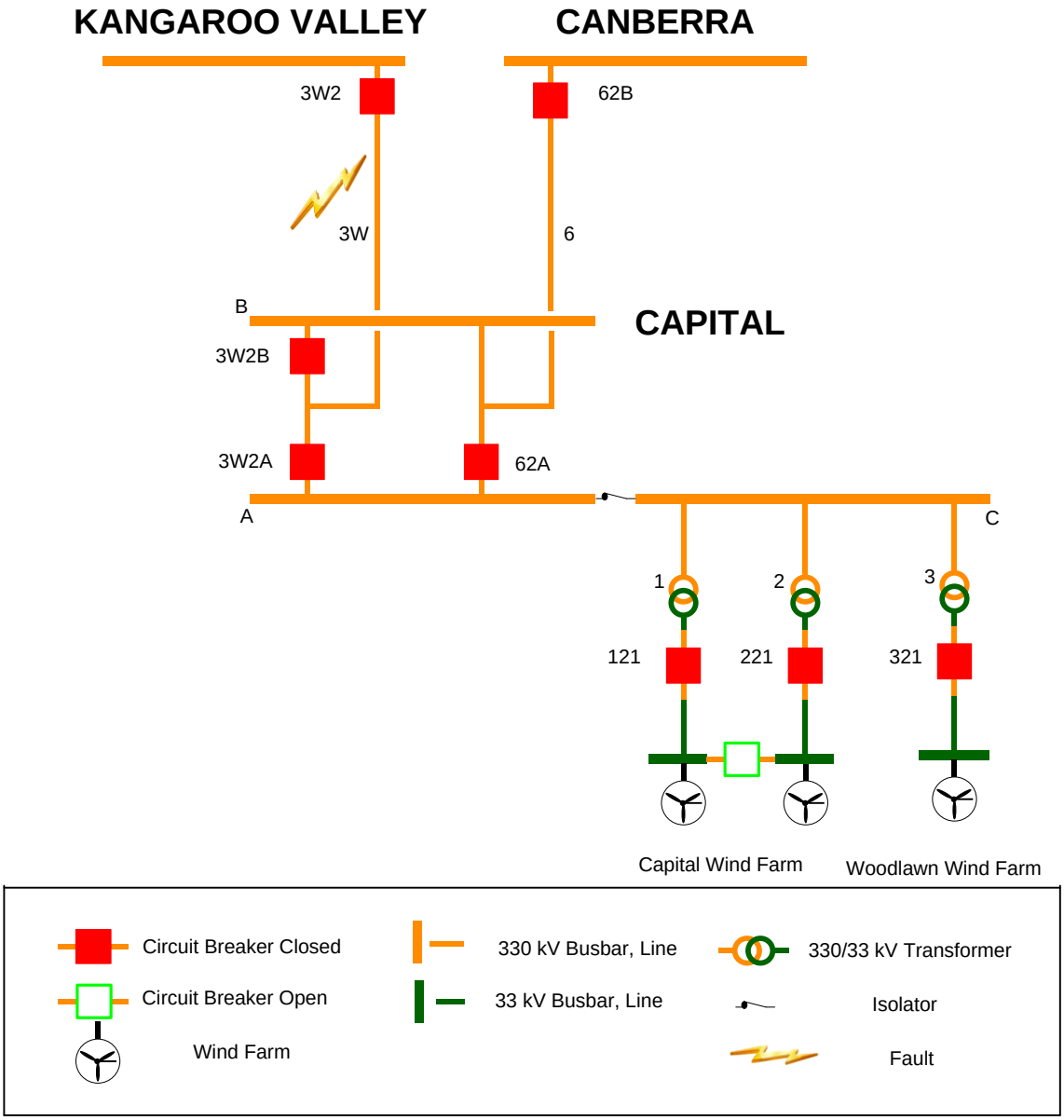

Figure 1- Status of the power system prior to the incident

3 Summary of Events

Date	Time (hrs)	Events
08 January 2013	13:46	The following elements tripped: • Canberra - Capital 6 330 kV Transmission Line opened at Capital end • Capital - Kangaroo Valley 3W 330 kV Transmission Line • Nos. 1, 2 and 3 33/330 kV Transformers at Capital Substation • A 330 kV busbar at Capital Substation

		• C 330 kV busbar at Capital Substation • Capital Wind Farm (99 MW) • Woodlawn Wind Farm (27 MW) The Capital - Kangaroo Valley 3W 330 kV Transmission Line auto-reclosed onto the B 330 kV Busbar at Capital Substation
	14:06	The Capital - Kangaroo Valley 3W 330 kV Transmission Line tripped and did not auto-reclose onto the B 330 kV Busbar at Capital Substation
	17:21	Canberra - Capital 6 330 kV Transmission Line and A 330 kV Busbar at Capital Substation returned to service
	17:29	Capital Wind Farm returned to service
	17:41	Woodlawn Wind Farm returned to service
10 January 2013	16:56	The Capital - Kangaroo Valley 3W 330 kV Transmission Line returned to service

At 1346 hrs on 8 January 2013, a high impedance phase to earth fault on the Capital - Kangaroo Valley 3W 330 kV Transmission Line was detected by protection systems. Trip signals were initiated to open the following elements as designed to clear the fault:

- 330 kV Circuit Breaker (CB) 3W2 at Kangaroo Valley Substation opened within 190 ms
- 330 kV CB 3W2A and CB 3W2B at Capital Substation opened within 240 ms

During the process of clearing the fault on the Capital - Kangaroo Valley 3W 330 kV Transmission Line, the earth fault protection on No.2 33/330 kV Transformer at Capital Substation was triggered. As a result, the following elements opened which cleared the A and C 330 kV Busbars at Capital Substation:

- 330 kV CB 62A at Capital Substation (Canberra - Capital 6 330kV Transmission Line remained energised from B 330 kV Busbar at Capital Substation)
- 33 kV CB 121 and CB 221 at Capital Substation (opening the line to the Capital Wind Farm)
- 33 kV CB 321 at Capital Substation (opening the line to the Woodlawn Wind Farm)

The Capital and Woodlawn wind turbines tripped on high voltage protection as designed.

After several seconds, the Capital - Kangaroo Valley 3W 330 kV Transmission Line auto-reclosed as designed onto the B 330 kV Busbar at Capital Substation.

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

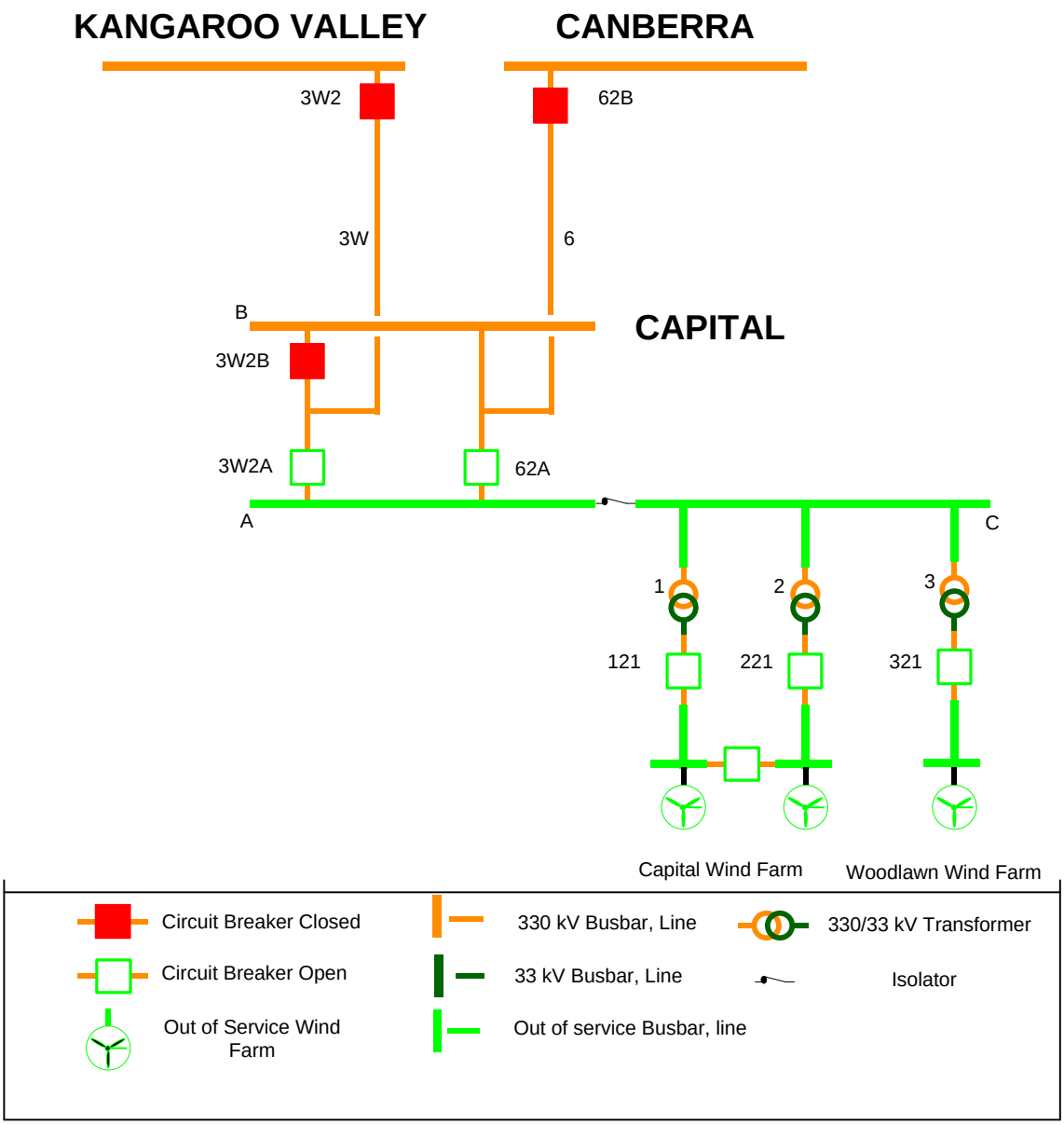

Figure 2 - Status of the power system after the trip at 1346 hrs

At 1406 hrs, another high impedance phase to earth fault on the Capital - Kangaroo Valley 3W 330 kV Transmission Line was detected by protection systems. The Capital – Kangaroo Valley 3W 330 kV Transmission Line tripped to lockout.[1]

Figure 3 shows the status of the power system after the trip at 1406 hrs.

[1] If a fault has not cleared before the auto –reclose function recloses the relevant circuit breakers the line will trip again and remain open. Similarly if another fault occurs within 35 seconds of a successful auto-reclose the line will again trip and remain open.

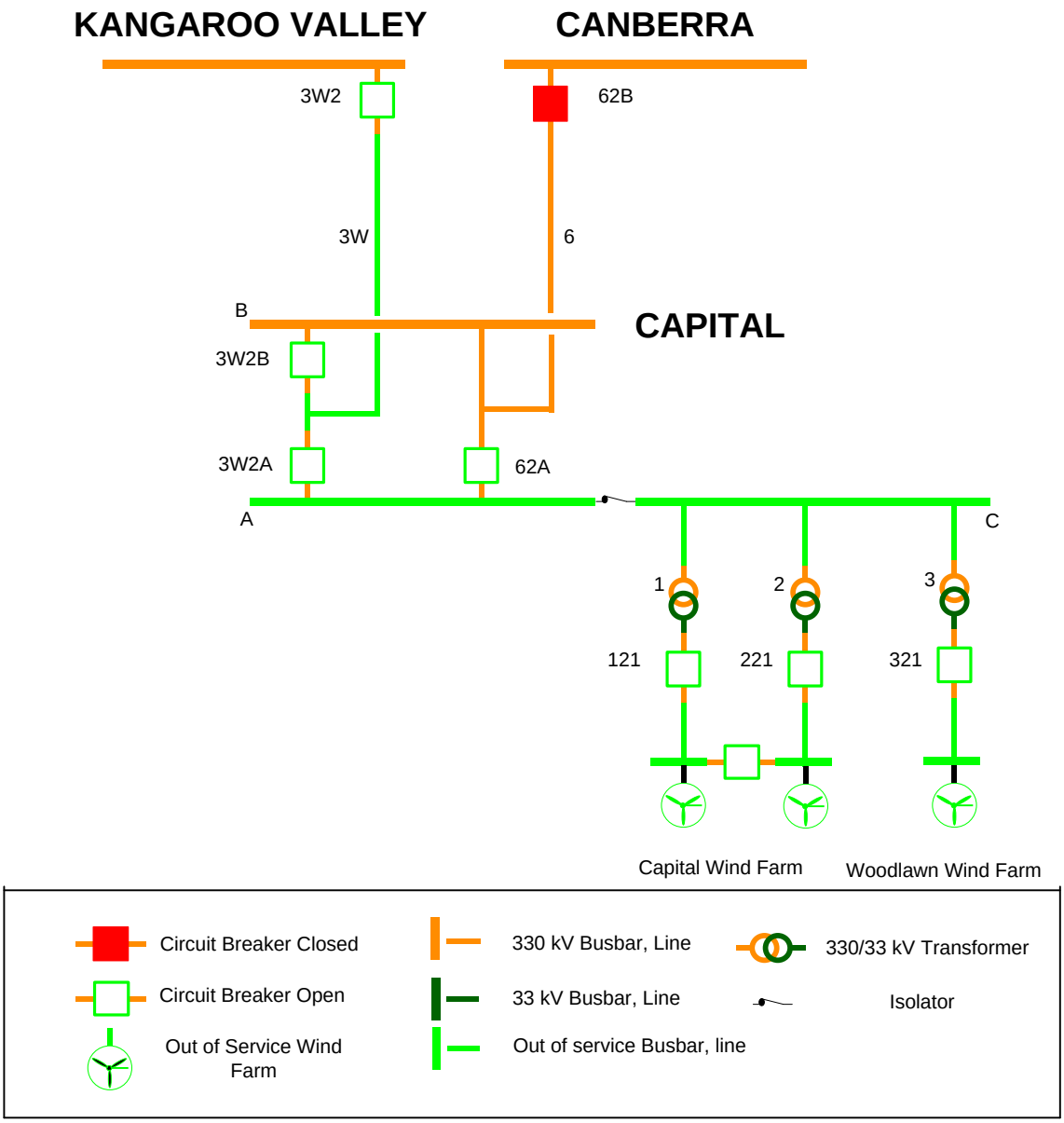

Figure 4 Status of the power system after the trip at 1406 hrs

4 Immediate Actions Taken

AEMO and Transgrid were aware of the extreme weather conditions and the possibility of bush fires that day. Notification from Indji Watch[2] was received by AEMO at 1350 hrs, shortly after the event indicating that fires were detected in the vicinity of the Capital - Kangaroo Valley 3W 330 kV Transmission Line.

Transgrid were not immediately able to conduct a line patrol on the Capital - Kangaroo Valley 3W 330 kV Transmission Line due to the intense fire that was present in the vicinity of the area. A line patrol was carried out on 9 January 2013 when the bushfire had been safely cleared.

The table below summarises the actions taken by AEMO on 8 January 2013 during the event:

[2] The Indji Watch system relies on satellites to detect hot spots. The satellites can fail to detect fires due to a number of reasons, including cloud cover, dense canopy or low intensity of the fire at the time the satellite passed overhead.

Time (hrs)	Events
14:07	AEMO issued Market Notice No. 40967 to advise the market of the non-credible contingency event at 1346 hrs
14:20	AEMO invoked constraint set N-KVCW-3W at 1420 hrs after the Capital - Kangaroo Valley 3W 330 kV Transmission Line tripped again at 1406 hrs and remained out of service.
14:22	AEMO issued Market Notice No. 40969 to advise the market of the non-credible contingency event at 1406 hrs
14:37	AEMO issued Market Notice No. 40970 declaring the simultaneous trip of the Canberra - Capital 6 and Capital - Kangaroo Valley 3W 330 kV Transmission Lines as a credible contingency event from 1406 hrs until further notice.
17:30	AEMO issued Market Notice No. 40973 to end the classification of the simultaneous trip of the Canberra - Capital 6 and Capital - Kangaroo Valley 3W 330 kV Transmission Lines as a credible contingency event. The simultaneous tripping of the Capital - Kangaroo Valley 3W 330 kV Transmission Line and A 330 kV Busbar at Capital Substation was reclassified as a single credible contingency event from 1730 hrs 8 Jan until further notice.

Table 1 Sequence of events

In assessing the event, AEMO considered the information provided by Transgrid at the time that the multiple element trips were due to protection system malfunction and correctly applied Section 12.5 - Reclassification due to “Other” Threats of the Power System Security Guidelines.

Transgrid were able to assess the 330 kV busbars at Capital Substation and the Canberra - Capital 6 330 kV Transmission Line before the 330 kV busbars and 330 kV transmission line was returned to service at 1721 hrs on 8 January 2013. The Capital and Woodlawn Wind Farms were returned to service at 1729 hrs and 1749 hrs on 8 January 2013 respectively.

5 Follow-up Actions

Once Transgrid conducted a line patrol and assessed the equipment for damage, the Capital - Kangaroo Valley 3W 330 kV Transmission Line was returned to service at 1656 hrs on 10 January 2013. Investigations by Transgrid determined that a phase to earth fault occurred approximately 95 km from the Capital Substation end of the Capital - Kangaroo Valley 3W 330 kV Transmission Line. The likely cause of this fault was the bushfires that occurred within the vicinity of the Capital - Kangaroo Valley 3W 330 kV Transmission Line.

Despite being similar transformers, the protection on No. 1 33/330 kV Transformer at Capital Wind Farm did not operate in a similar way to No. 2 33/330 kV Transformer at Capital Wind Farm. Infigen Energy will investigate the protection settings on the No. 1 33/330 kV transformer at Capital Wind Farm as part of their major HV service that will occur in May to determine why it did not detect and respond to the phase to earth fault. Even though the 2 Transformer protection operated in accordance with its settings this is an inappropriate outcome in that a line fault should be cleared by the line protection prior to the operation of the transformer protection.

In addition, Infigen Energy will cooperate with Transgrid to determine appropriate transformer protection settings to allow the protection system on transmission lines sufficient time to operate. Infigen Energy will inform AEMO once these protection setting changes have been implemented.

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.

Although a longer clearance time compared to other types of faults was taken to due to the high impedance nature of the fault, the clearance time conforms to NER Section S5.1.9 (k).

AEMO's reclassification of the simultaneous trip of the Capital - Kangaroo Valley 3W 330 kV Transmission Line and A 330 kV Busbar at Capital Substation as a single credible contingency event will remain in place until appropriate protection setting changes have been implemented.

7 Conclusions

The multi-element trips that occurred on 8 January 2013 were caused by bushfires that resulted in a phase to earth fault. While the initial fault was cleared by the Capital - Kangaroo Valley 3W 330 kV Transmission Line protection, the protection on No.2 33/330 kV Transformer at Capital Wind Farm also operated, however the protection on No.1 33/330 kV Transformer at Capital Wind Farm did not operate. Infigen Energy will review the protection settings on the 33/330 kV transformers at Capital Wind Farm.

All elements were returned to service promptly once they had been inspected.

AEMO correctly applied the criteria in Section 12.5 - Reclassification due to "Other" Threats published in the Power System Security Guidelines.

8 Recommendations

Infigen Energy will review the protection schemes and protection settings on the transformers at Capital Wind Farm by 31 May 2013 and advise AEMO of the outcomes. AEMO will then consider ending the reclassification of the simultaneous trip of the Capital - Kangaroo Valley 3W 330 kV Transmission Line and A 330 kV Busbar at Capital Substation as a single credible contingency event.