

TRIP OF HAZELWOOD NO.2 220 KV BUS ON 28 DECEMBER 2010

PREPARED BY: Electricity System Operations Planning and Performance

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FINAL

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1 Introduction

At 0103 hrs on 28 December 2010, the Hazelwood power station operator attempted to select the Hazelwood generating unit G5 for synchronising to the power system through the No.5 generator 220 kV circuit breaker. However the generator circuit breaker prematurely closed due to a malfunctioning relay and attempted to connect the generating unit to the No.2 220 kV busbar without synchronism. A failure of the protection trip of that circuit breaker caused the subsequent back-up trip of the Hazelwood No.2 220 kV busbar, resulting in tripping of the Hazelwood generating unit G4 and off-loading of the Hazelwood No. 1 500/220 kV transformer and Hazelwood – Jeeralang No.2 220kV transmission line.

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 International Power. 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

The Hazelwood generating units are synchronised to the power system via the associated 220 kV circuit breakers at Hazelwood power station switchyard. Generating units G3, G4 and G5 are normally connected to the Hazelwood No.2 220 kV bus. Typically, generating units G1 and G2 are connected to the Hazelwood No.1 220 kV bus and generating units G6 to G8 are connected to another section of the Hazelwood 220 kV system.

On 28 December 2010, preparations were made to synchronise generating unit G5 to the Hazelwood No.2 220kV bus. The generating units G1, G2 and G4 were generating approximately 161 MW, 180 MW and 217 MW respectively at the time. Generating unit G3 was out of service on the day of the event. Figure 1 below illustrates the status of relevant network elements at Hazelwood power station switchyard before the incident occurred. Figure 1 also illustrates the boundary between International Power and SP AusNet assets.

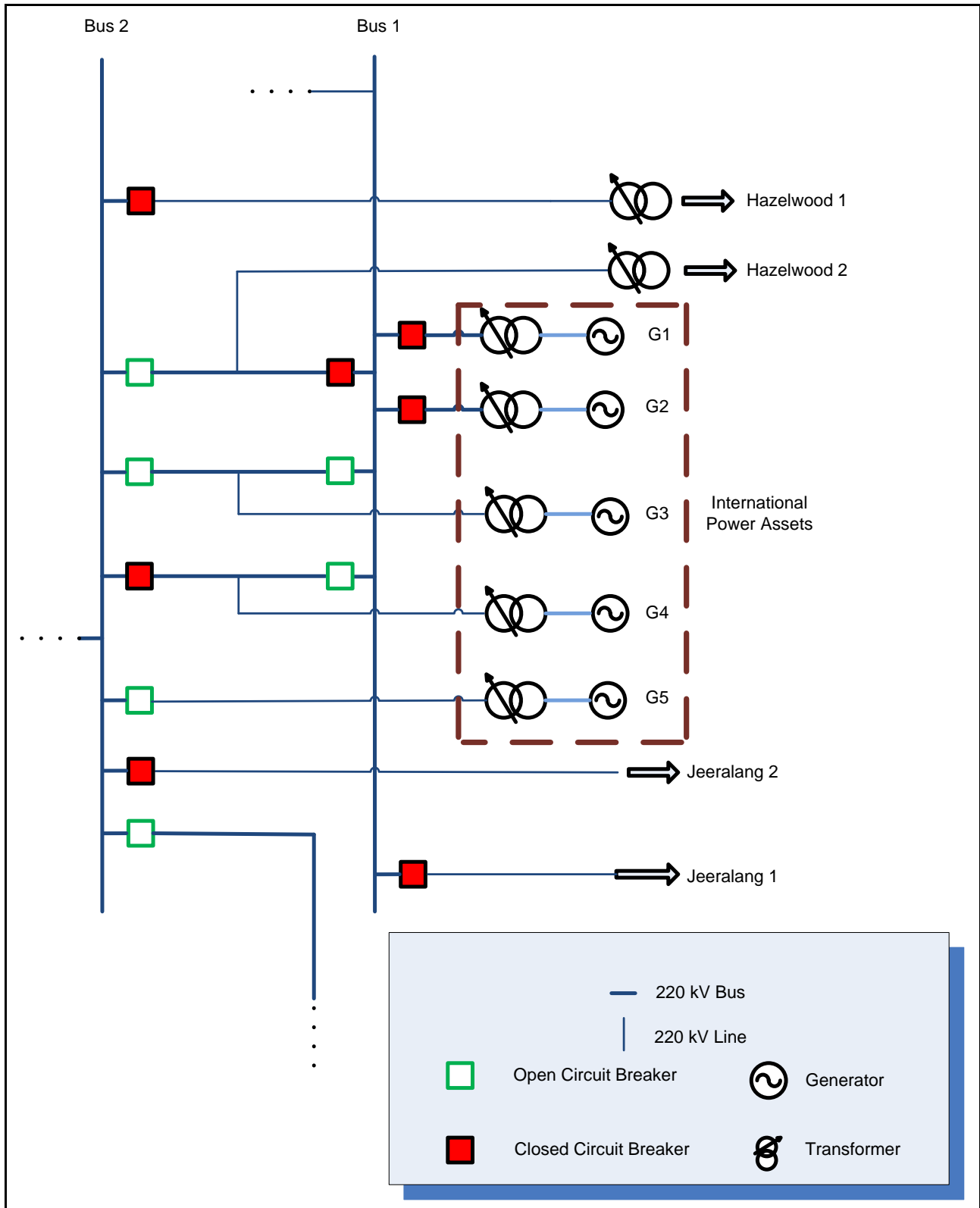


Figure 1 Simplified Hazelwood Power Station 220 kV system configuration before the incident occurred

Generating units at Hazelwood power station require manual synchronising using 220 kV circuit breakers at Hazelwood power station switchyard. Automatic synchronising equipment is not installed at Hazelwood power station.

When the Hazelwood power station operator selected generating unit G5 for synchronising at 0103 hrs, the No.5 generator 220kV circuit breaker prematurely closed without operator command and hence without synchronism of generating unit G5 to the power system. Investigations revealed that

a faulty relay caused a signal to be sent to close the No.5 generator 220kV circuit breaker without synchronising. Voltage, current, MW and MVar swings were registered by SP AusNet's digital fault recorders and system dynamic monitors following the closure of the circuit breaker.

The No.5 generator transformer differential protection operated to trip generating unit G5 by attempting to open No.5 generator 220 kV circuit breaker. However the red phase of No.5 generator 220 kV circuit breaker failed to open properly. After 810 ms following the circuit breaker closure, a flashover to earth occurred in the red phase tank of the Hazelwood G5 220 kV circuit breaker.

Within 110 ms of the detection of this earth fault the generating unit G5 X and Y protections operated along with the Hazelwood No.2 220 kV bus X and Y protections, resulting in the trip of all network elements connected to the No.2 220 kV bus: the Hazelwood generating unit G4, Hazelwood to Jeeralang No.2 220 kV transmission line and Hazelwood 220/500 kV transformer.

AEMO issued Market Notice No. 33853 at 0129 hrs to advise the market of the bus tripping and the loss of generation as a non-credible contingency event.

The restoration of the Hazelwood No. 2 220 kV bus along with the Hazelwood No. 1 220/500 kV transformer and Hazelwood – Jeeralang No.2 220 kV transmission line was completed by 0152 hrs and was advised by AEMO in Market Notice No. 33855 issued at 0218 hrs.

Figure 2 below shows the status of the relevant network elements at Hazelwood power station switchyard after the Hazelwood No. 2 220 kV bus trip.

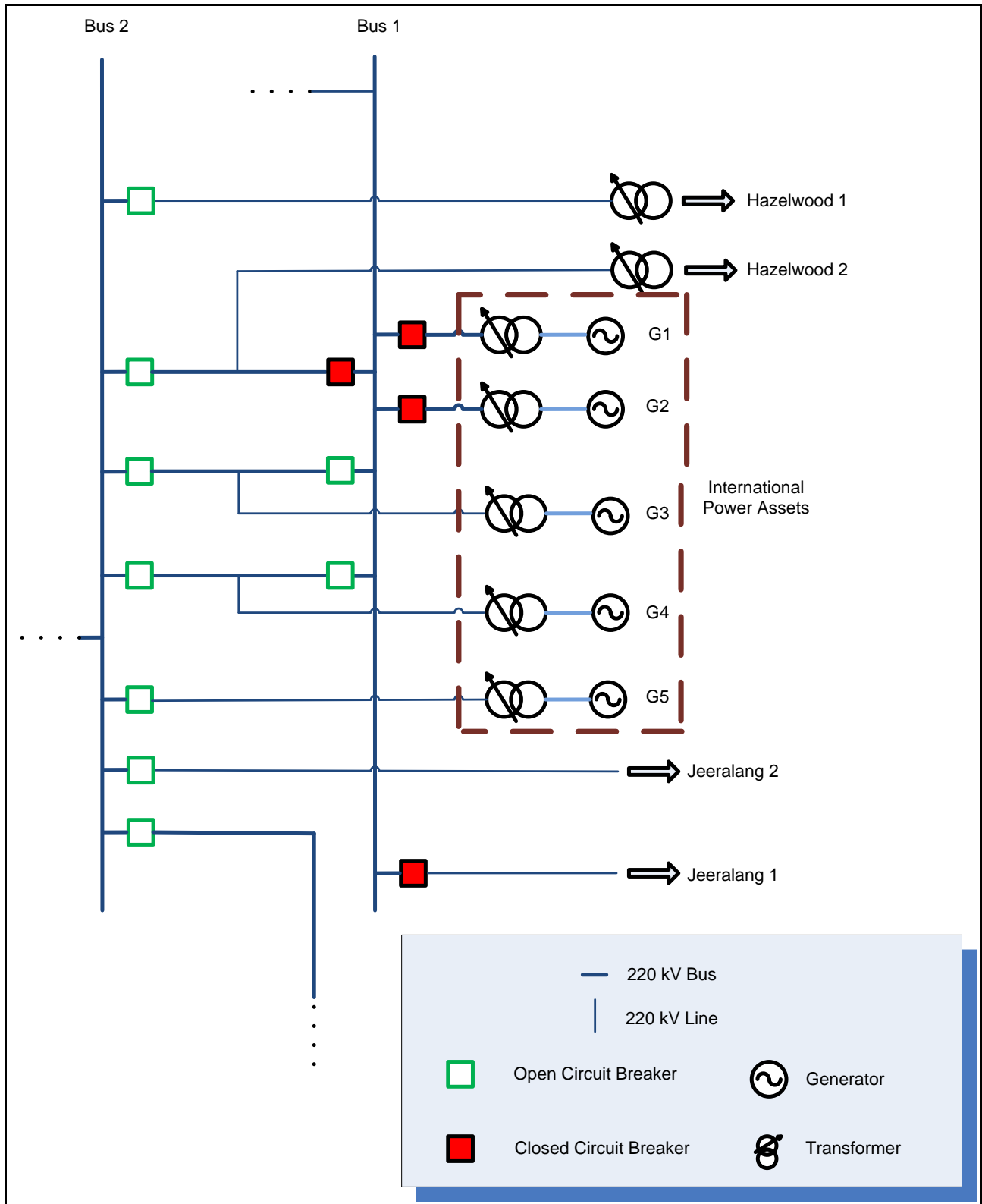


Figure 2 Simplified Hazelwood Power Station 220 kV system configuration after the No. 2 bus tripped

3 Power System Security Assessment

Despite losing 217 MW of generation due to the tripping of Hazelwood generating unit G4, the power system remained in a secure operating state. No security violations were reported by

AEMO's real time contingency analysis tool and the power system frequency remained within the normal operating frequency band throughout the incident.

All protection systems operated as designed and all affected power system elements returned to service without any operational issues.

4 Follow Up Actions

SP AusNet replaced the faulty No.5 generator 220 kV circuit breaker with a new circuit breaker and made it available for service on 14 January 2011.

In March 2011 SP AusNet disassembled the failed No.5 generator 220 kV circuit breaker in the presence of the manufacturers. The manufacturers are expected to report back to SP AusNet on the cause of the failure by the end of May 2011.

As a temporary measure to prevent a reoccurrence of the synchronising malfunction, Hazelwood power station operators will visually check that relays associated with connecting the generator unit to the power system are in a safe state prior to synchronising generating units. This mitigating control will apply to Hazelwood generating units G3 to G8.

As a permanent solution International Power has commenced a project to replace the manual relay check with a synchronising check relay on generating G5 unit to ensure secure synchronism. Installation of synchronising check relays on generating units G3, G4, G6, G7 and G8 is also being considered. Synchronising check relays have already been installed on generating units G1 and G2.

5 Conclusion

On 28 December 2010 the Hazelwood No.2 220 kV bus tripped, resulting in the trip of generating unit G4 and the off-loading of the Hazelwood No. 1 500/220 kV transformer and the Hazelwood - Jeeralang No.2 220 kV transmission line. The 220 kV bus tripped to clear an earth fault on red phase of the No.5 generator 220 kV circuit breaker which developed while opening. The No.5 generator 220 kV circuit breaker tripped due to operation of the No.5 generator transformer differential protection following the inadvertent closure of the No.5 generator 220 kV circuit breaker. The inadvertent closure of the No.5 generator 220 kV circuit breaker was caused by a malfunctioning relay that connected generating unit G5 to the power system without operator command.

6 Recommendation

1. SP AusNet will inform AEMO of the cause of failure of the Hazelwood No.5 220 kV circuit breaker, by the end of May 2011.
2. International Power will inform AEMO of progress with installing a synchronising check relay on generating unit G5, by the end of May 2011.
3. International Power will inform AEMO of progress in its review into installing synchronising check relays on generating units G3, G4, G6, G7 and G8, by the end of June 2011.