POWER SYSTEM INCIDENT REPORT

TRIP OF UPPER TUMUT TO CANBERRA AND UPPER TUMUT TO LOWER TUMUT 330KV LINES ON 27 MARCH 2010

PREPARED BY: Electricity System Operations Planning and Performance

VERSION NO: 1.0

FINAL

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1. Introduction

At 18:18 hours on 27 March 2010 the 01 Upper Tumut to Canberra 330 kV line (Line 01) tripped, auto-reclosed, tripped and locked-out due to a mid-span joint failure. Coincidently the 64 Upper Tumut to Lower Tumut 330 kV line (Line 64) opened at Upper Tumut. Approximately 21 MW of generation at the Capital Hill wind farm was also interrupted when a significant number of wind turbines tripped out of service at the same time.

Information for this report has been supplied to AEMO by TransGrid. Data from AEMO's Energy Management System has also been used in analysing the event.

All references to time in this report refer to Market time (Australian Eastern Standard Time).

2. Summary of Events

At 18:18 hours on 27 March 2010, a mid-span joint failed on Line 01 causing one of the three phase conductors (white phase) to fall to the ground. The mid span failure occurred approximately 20 km from the Upper Tumut substation. The grounding of the phase conductor produced a fault that caused Line 01 to trip, auto-reclose, trip and lock out. The configuration of the power system at the time of the fault can be seen in Figure 1.

Coincident to the trip of Line 01 were the opening of Line 64 at the Upper Tumut substation and the loss of 21 MW of generation (27 wind turbine generating units) at Capital Hill Wind Farm. The configuration of the power system immediately following the fault is shown in Figure 2.

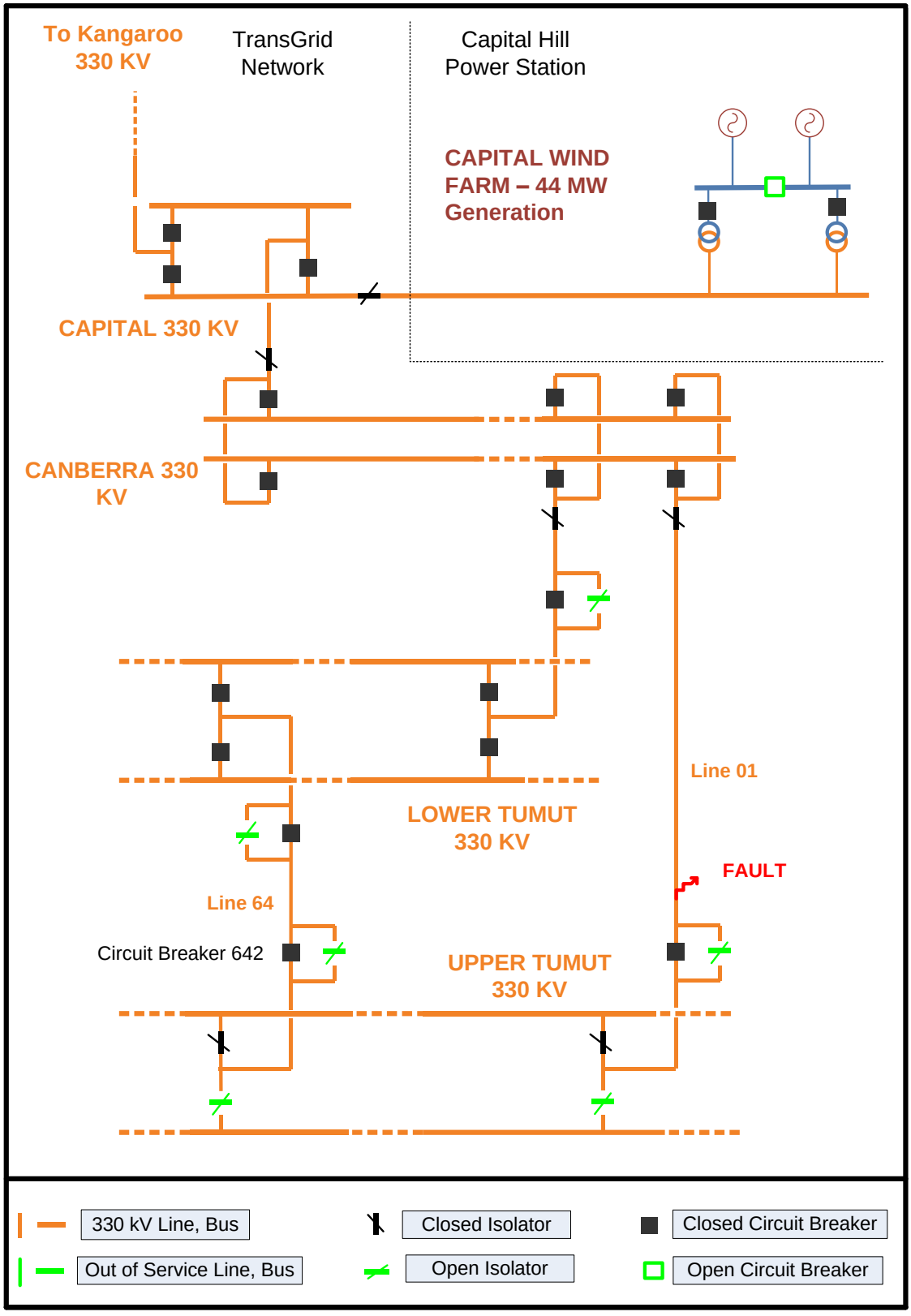

FIGURE 1 – POWER SYSTEM CONFIGURATION AT THE TIME OF FAULT AT 07:18 ON 27 MARCH 2010

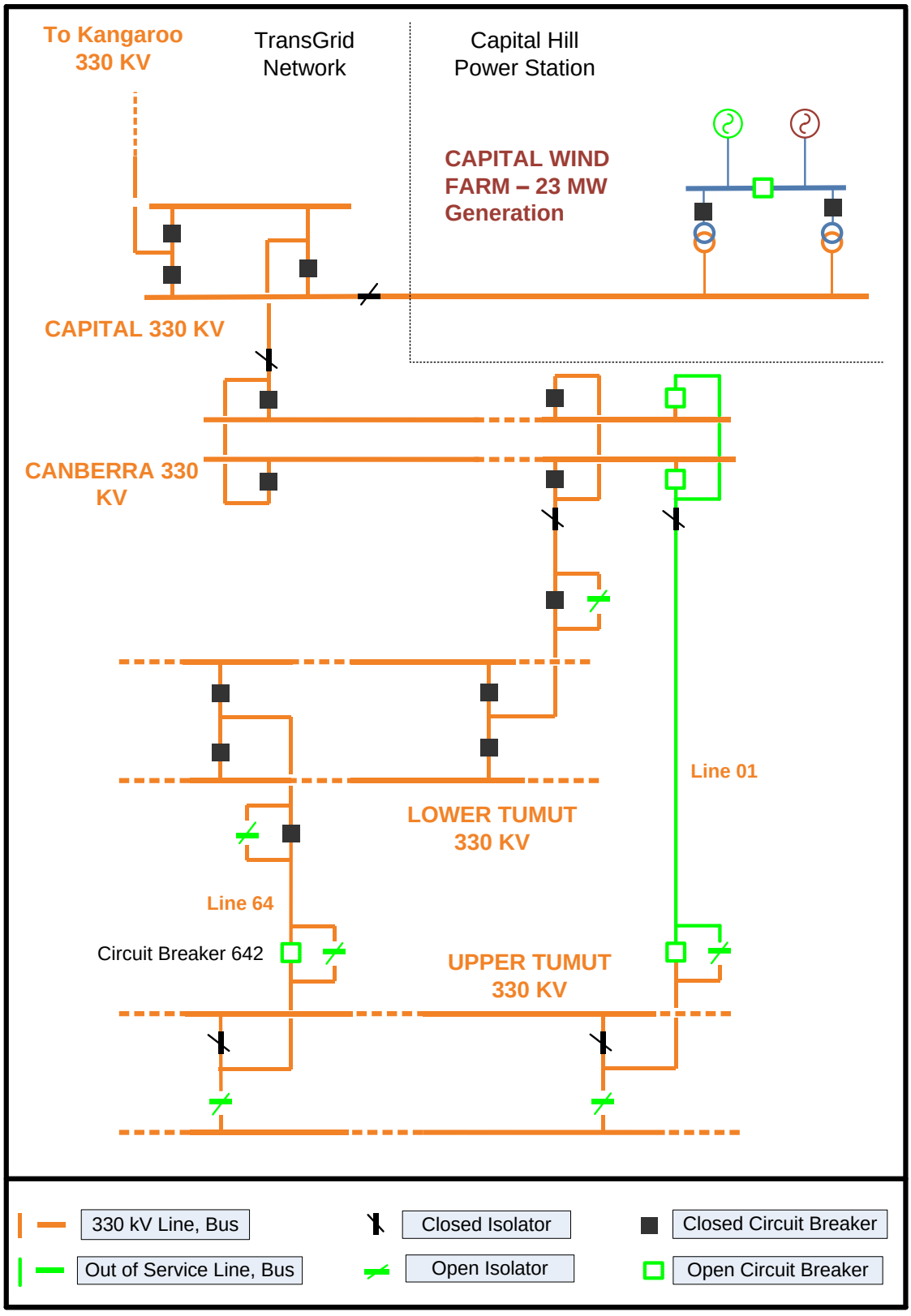

FIGURE 2 – POWER SYSTEM CONFIGURATION AFTER LINE 01 AUTO-RECLOSED AND LOCKED-OUT AT 07:18 ON 27 MARCH 2010

There was no interruption to the supply of electricity as a result of the fault and associated line trips.

The Line 64 was returned to service at 19:15 hrs on 27 March. Following an aerial patrol Line 01 was repaired and returned to service at 19:34 hrs on 28 March.

All wind turbines at Capital Hill Wind Farm that tripped were returned to service approximately 40 minutes after the failure of Line 01.

3. Power System Security Assessment

The fault caused by the mid-span failure of Line 01 was cleared in 100 ms from the Upper Tumut 330 kV substation by the Line 01 zone 1 distance protection system and in 340 ms from the Canberra 330 kV substation by Line 01 Directional Earth Fault (DEF) protection system.

The time taken to clear the fault from the Upper Tumut end of Line 01 is within the time required by National Electricity Rules (NER) for the clearance of a short circuit fault[1].

The fault seen at the Canberra end of Line 01 was not a short circuit fault but rather a high impedance fault. The clearance time required for high impedance faults is not explicitly stated in the NER[2]. Rather the NER requires that a high impedance fault be cleared within sufficient time so that the power system does not become unstable, inter-regional or intra-regional power transfers are not unduly constrained, and consequential equipment damage is minimised. AEMO is currently performing studies to confirm whether the fault clearance time is acceptable.

15 seconds after the fault was cleared, Line 01 auto-reclosed at the Canberra substation. As the white phase conductor was still grounded at the time of the reclosing of Line 01 the fault on the line was still present. The fault was re-cleared in 300 ms from the Canberra substation by Line 01 protection systems. Line 01 did not auto-reclose at the Upper Tumut end. The Line 01 auto-reclose scheme at Upper Tumut requires Line 01 to be energised in order for reclosing to occur. AEMO is currently performing studies to confirm whether the fault clearance time following reclosing is acceptable.

Coincident to the trip of Line 01 the DEF protection relay of the No.2 protection system on Line 64 operated to trip circuit breaker 642 in the Upper Tumut 330 kV substation 120 ms after the fault. The cause of this mal-operation has not been established. The Line 64 stayed connected to Lower Tumut substation for the duration of the incident.

Line 64 did not auto-reclose at the Upper Tumut end of the line because the design is such that auto-reclose at this end of the line would take place only if the line was dead.

The Line 64 was subsequently placed on load at 19:15 hrs on the same day.

[1] Refer to schedule S5.1a.8(b) of the NER for more information.
[2] Refer to schedule S5.1a.8(a) of the NER for more information.

Approximately 320 ms following the initial fault, wind turbines at the Capital Hill Wind Farm started to trip due to the operation of current asymmetry protection. The single-line-to-ground fault caused by the failure of the “white” phase conductor of Line 01 caused negative sequence current to flow in the transmission network. Once the current asymmetry protection on a turbine detected current asymmetry above 300 amps the protection operated to trip the turbine following an 80 ms delay. In all 27 turbines tripped due to current asymmetry. The performance of the Capital Hill Wind Farm was within the requirements of its agreed performance standard.

4. Follow-up actions

Following the incident TransGrid tested the DEF relay of the Line 64 No.2 protection system at the Upper Tumut 330kV substation. The relay was found to be operating correctly and the reason for the mal-operation was unable to be established. Consequently TransGrid removed this DEF relay from operation. TransGrid intends to replace the relay by March 2011.

Until the replacement of the DEF relay of the Line 64 No.2 protection system, Line 64 will be protected by the No.1 protection system at Upper Tumut substation, and the distance protection relay of the No.2 protection system. The No.1 protection system has both earth fault (DEF) relays and distance relays. If the No.1 DEF relay becomes inoperable then AEMO and TransGrid will consider available options to ensure that the power system is adequately protected. Options include, but are not limited to, installing a temporary DEF protection or taking Line 64 out of service. TransGrid and AEMO believe that power system security can be maintained during the period of the Line 64 No.2 DEF relay outage.

AEMO is undertaking studies to determine if the clearing times of the high impedance faults on Line 01 were acceptable. If the clearing times are not acceptable then AEMO will liaise with TransGrid to rectify the problem.

5. Recommendation

TransGrid will replace the DEF relay associated with the No.2 protection system of Line 64 at the Upper Tumut 330kV substation by March 2011 and advise AEMO of the completion of this task.

AEMO will complete studies to determine if the clearing times of the high impedance faults on Line 01 are acceptable by December 2010.