POWER SYSTEM INCIDENT REPORT
TRIP OF MULTIPLE 132 KV TRANSMISSION LINES NEAR MACKAY SUBSTATION AND NEBO SVC ON 3 JANUARY 2011

PREPARED BY: ESOPP

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FINAL

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1 Introduction

On Monday 3 January 2011, a fault on a 33 kV line connected to T38 Mackay substation led to the loss of all four 132 kV transmission lines supplying the substation and the tripping of the static VAr compensator at the Nebo 275 kV substation.

Approximately 76 MW of load supplied from the T38 Mackay and Proserpine substations was interrupted during the incident.

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 Powerlink and Ergon Energy. 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

On 3 January 2011 the T38 Mackay 132 kV substation was operating in its system normal configuration. The Mackay gas turbine (Mackay GT) was not in service at the time. Refer Figure 1 for the network configuration at T38 Mackay substation and the network connections to H11 Nebo, T141 Pioneer Valley and T37 Collinsville substations before the event. For clarity, only plant and equipment that operated or provided connectivity between affected sites are shown in the diagram.

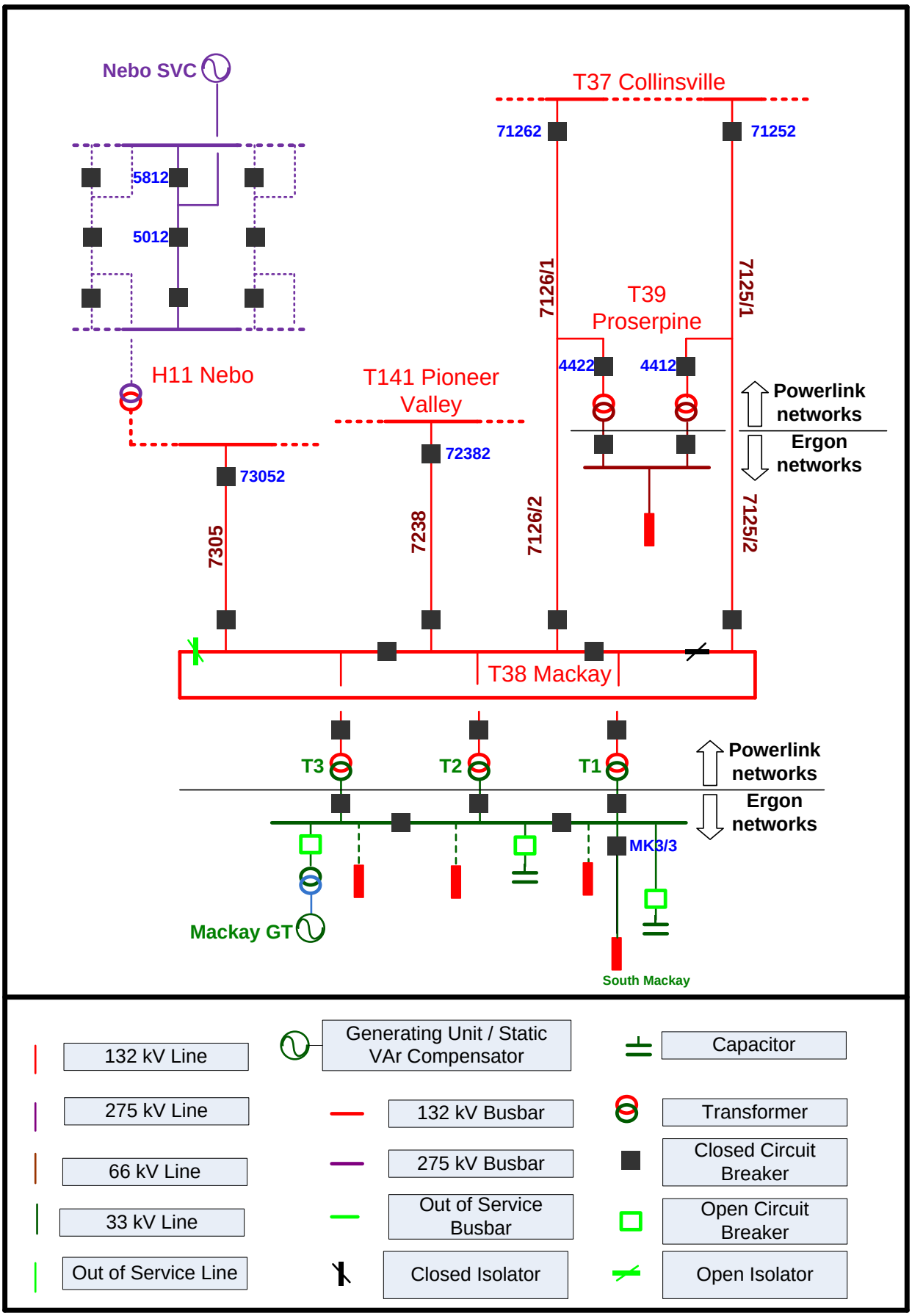

Figure 1 –Network in the vicinity of T38 substation and the connections to H11, T141, and T37 substations before the event

At 0628 hrs on 3 January 2011 a cable fault developed at the South Mackay end of the Mackay – South Mackay 33 kV line. During an attempt to clear this fault, circuit breaker MK3/3 in the T38 Mackay substation failed catastrophically.

A fault developed in the 33 kV feeder bay where circuit breaker MK3/3 is located. The fault occurred when energised components of the failed circuit breaker made contact with structures in the feeder bay. The 33 kV busbar protections failed to clear the fault on circuit breaker MK3/3, leaving a sustained fault in the 33 kV feeder bay.

The structures in the feeder bay that were in contact with energised components of the failed circuit breaker are connected to earth by an earth bond. The fault current passing through the earth bond caused the earth bond to burn off, disconnecting the structures from earth. This caused the structure to become energised.

As a result of the structure becoming energised, a flashover occurred between the structure and the substation's secondary system wiring. The flashover caused fault current to flow through the secondary system wiring, damaging the 110V battery charger, 110V direct current busbar and several 33 kV line protection and control panels.

The damage caused the 110V direct current circuit breakers which supply power to all protection and control systems at T38 Mackay substation to open. This rendered all protection and control systems at the T38 Mackay substation inoperative. Hence the high voltage fault could not be cleared by any local backup protection systems at the T38 Mackay substation.

The fault was detected by the protection systems in substations at remote ends of 132 kV lines that connect T38 Mackay. These lines are 7125, 7126, 7238 and 7305. The protection systems cleared the fault from the system by opening circuit breakers 71252, 71262, 72382 and 73052.

The tripping of these four lines resulted in the loss of 132 kV supply to Mackay and Proserpine substations. As a result, approximately 36 MW load supplied from Proserpine substation and approximately 40 MW load supplied from T38 Mackay substation was interrupted. Ergon Energy restored some load via their 33kV system and performed rotational shedding of load that could not be supplied.

The fault at the Mackay substation caused a voltage depression on the 132 kV network. The static VAr compensator in the H11 Nebo substation responded to the voltage depression by increasing its capacitive reactive power output. The prolonged nature of the fault and associated voltage depression caused a high voltage condition on the static VAr compensator's reactive components.

The high voltage condition caused the static VAr compensator's protection system to trip the compensator by opening circuit breakers 5812 and 5012 at the Nebo 275 kV substation.

Refer Figure 2 for the network configuration at T38 substation and the connections to H11, T141 and T37 substations immediately after the two faults.

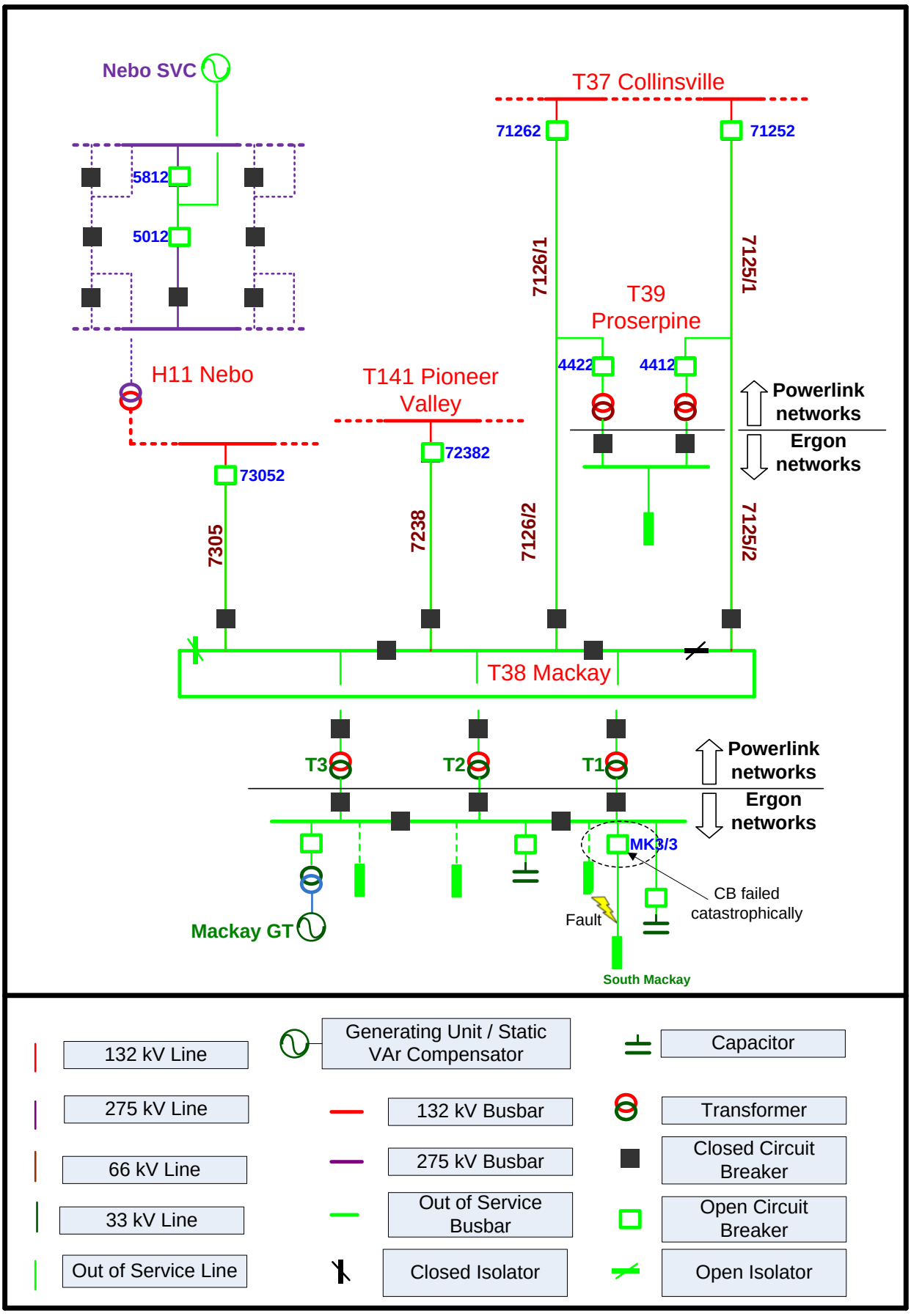

Figure 2 – Network in the vicinity of T38 substation and the connections to H11, T141, and T37 substations immediately after the event

3 Immediate actions

Market Notice 33926 was issued by AEMO to notify participants of the occurrence of this non-credible contingency in Queensland.

Constraint set Q-H11NE_SVC for the loss of Nebo SVC was invoked at 0640 hrs on 3 January 2011. The constraint set Q-MK_33BUS should have been invoked at the same time to prevent Mackay GT to be dispatched for FCAS and/or energy. This constraint set was only invoked from 1240 hrs on 3 January 2011.

At 0858 hrs on 3 January 2011 the 7125/2 and 7126/2 132 kV lines were closed at Collinsville and Proserpine, restoring supply to Proserpine substation.

At 1859 hrs on 3 January 2011 the 7305 Nebo – Mackay 132 kV line was returned to service, restoring 132 kV supply to Mackay substation.

At 1921 hrs on 3 January 2011 the 132 kV busbar at T38 Mackay was energised. At 2313 hrs on 3 January 2011, the 33 kV busbar was energised, facilitating load restoration at Mackay. All non-switchable load was restored by 0026 on 4 January 2011.

At 0453 hrs on 4 January 2011 the Mackay to Pioneer Valley 132 kV line was returned to service.

At 0836 hrs on 4 January 2011 the Nebo SVC was returned to service. Constraint set Q-H11NE_SVC was then revoked by AEMO.

At 1501 hrs on 5 January 2011 the 7125 Mackay to Collinsville 132 kV line was closed at Mackay substation.

At 1704 hrs on 6 January 2011 the 7126 Mackay to Collinsville 132 kV line was closed at Mackay substation.

4 Follow up actions

The relevant 33 kV and 132 kV busbar and feeder protection relays were tested and repaired as required by both Ergon Energy and Powerlink.

Ergon Energy and Powerlink have completed official investigations into this incident.

5 Power System Security

The power system remained in a secure operating state during the incident.

Power system frequency remained within the normal operating frequency band during the event.

76 MW of load at Mackay and Proserpine was interrupted as a result of the event.

The reason for failure of the 33 kV busbar protections to operate at T38 and clear the 33 kV circuit breaker fault could not be established due to the unavailability of information on the operation of secondary systems. The information was not available as a result of the massive damage to secondary systems experienced at T38 Mackay.

Due to the delay in invoking the constraint set Q-MK_33BUS the Mackay GT received a 5-minute Raise FCAS target of 13 MW until the constraint set Q-MK_33BUS was invoked. The Mackay GT was unable to provide FCAS services while it was out of service but this did not create a material impact on power system security.

6 Conclusions

At 0628 hrs on 3 January 2011, the explosive failure of a 33 kV circuit breaker at the T38 Mackay substation caused a high voltage fault. The 33kV busbar protections failed to clear the fault. The circuit breaker failure also caused the loss of DC supply at T38 Mackay making secondary systems and circuit breakers inoperative. The fault was then successfully cleared via the operation of

remote back up protections, tripping the remote ends of all 132 kV lines supplying Mackay substation.

Approximately 36 MW load at Proserpine and 40 MW of load at Mackay were interrupted during the event.

The constraint set Q-MK_33BUS was not invoked immediately following the incident and as a result Mackay GT was dispatched for 13 MW of 5-minute Raise FCAS service. The Mackay GT could not be immediately returned to service nevertheless there was no material impact on the power system security.

7 Recommendations

1. Ergon Energy will investigate whether the 33kV busbar protection system at T38 Mackay substation needs further testing, including simulation of the conditions experienced on the day to establish the 33kV busbar protection system at T38 Mackay meets the required level of reliability, dependability and security. Ergon Energy will complete this action by the end of August 2011.
2. Powerlink will review the remote end protection settings to confirm that the currently applied settings are applicable for the system conditions experienced on 3 January 2011. Powerlink will complete this action by the end of July 2011.
3. Powerlink will investigate the operation of Nebo SVC during this incident and report the corrective action required for the SVC to remain in service during severe voltage disturbances. Powerlink will complete this action by the end of July 2011.
4. In light of this power system incident, AEMO Power System Operations will emphasize its procedure for invoking constraints to staff in their routine team discussions to avoid similar outcomes in future. AEMO will complete this action by the end of July 2011.