

POWER SYSTEM OPERATING INCIDENT REPORT – LIGHTNING STRIKES IN TASMANIA AND PACIFIC ALUMINIUM POTLINE LOAD REDUCTIONS 21 MARCH 2013

PREPARED BY: Systems Capability

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FINAL

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Abbreviations and Symbols

Abbreviation	Term
AEMO	Australian Energy Market Operator
CB	Circuit Breaker
DI	Dispatch Interval
EMMS	Electricity Market Management System
EMS	Energy Management System
ENVI & LI	Environment and Lightning
kV	Kilovolt
MW	Megawatt
NER	National Electricity Rules
OFGSS	Tasmania Over-Frequency Generator Shedding Scheme
TL	Loss of transmission elements and load interruption

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Incident summary

Date and time of incident	1834 hrs 21 March 2013 1901 hrs 21 March 2013 2057 hrs 21 March 2013
Region of incident	Tasmania
Affected regions	Tasmania
Event type	Loss of transmission elements and load interruption (TL)
Primary cause	Environment and Lightning (ENVI & LI)
Impact	Significant
Associated reports	Nil

1 Introduction

Three contingencies occurred on the Tasmanian power system on 21 March 2013 that resulted in a reduction of load at the Pacific Aluminium potlines:

- a. Simultaneous loss of Farrell - Sheffield No.1 and No.2 220 kV transmission lines at 1834 hrs 21 March 2013. Pacific Aluminium reduced in load by 118 MW.
- b. Loss of George Town – Sheffield No.2 220 kV transmission line at 1901 hrs 21 March 2013. Pacific Aluminium reduced in load by 100 MW.
- c. Loss of George Town - Sheffield No.2 220 kV transmission line at 2057 hrs 21 March 2013. Pacific Aluminium reduced in load by 221 MW.

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 Transend. AEMO's Energy Management System (EMS) and Electricity Market Management System (EMMS) have 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 Incident in Tasmania at 1834 hrs 21 March 2013

2.1 Pre-Contingent System Conditions

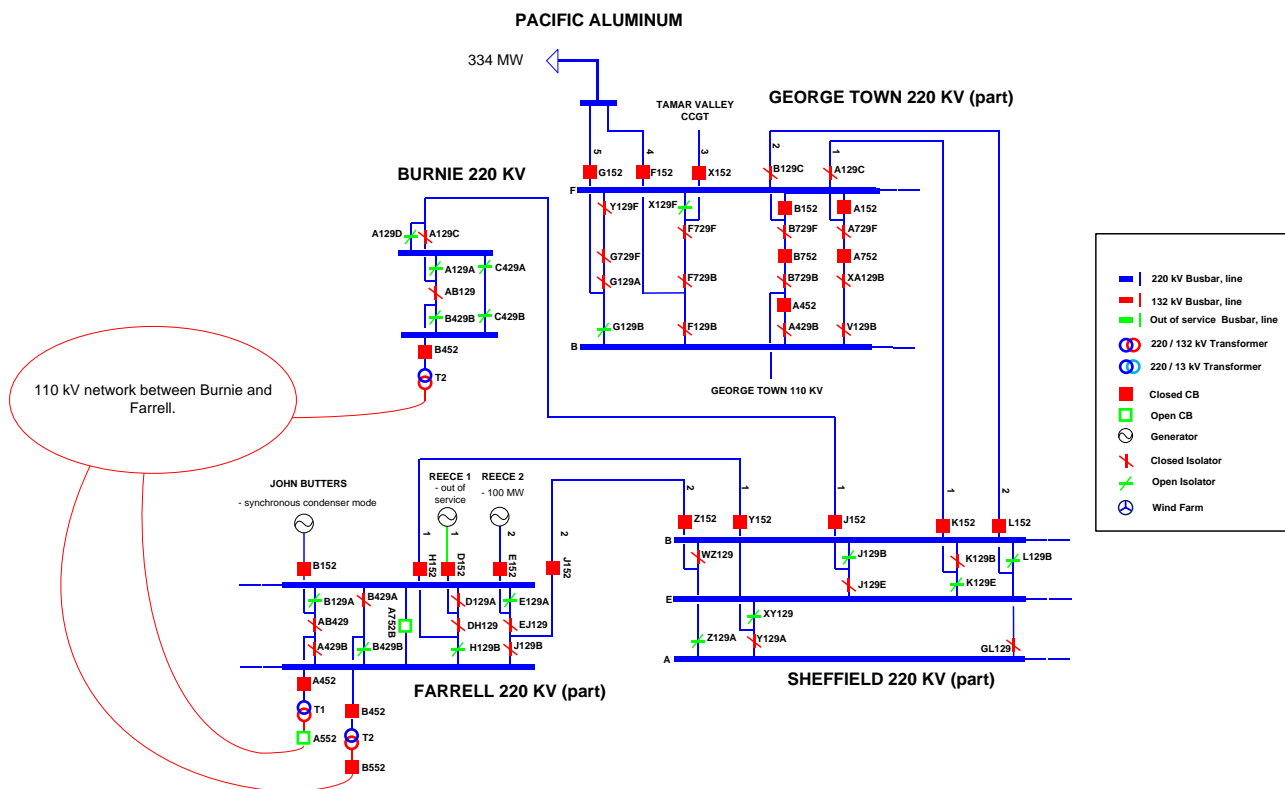
There was significant lightning activity across Tasmania on 21 March 2013. The following contingencies had been re-classified as credible due to lightning:

- a. Simultaneous loss of Farrell – Reece No.1 and No.2 220 kV transmission lines. Constraint set F-T-FARE_N-2 was invoked in DI ending 1555 hrs. Market Notice 41961 was issued at 1556 hrs.
- b. Simultaneous loss of Farrell – Sheffield No.1 and No.2 220 kV transmission lines. Constraint sets F-T-FASH_N-2, T-FASH_N-2_HM_C and T-NIL_HM_CLOSE were invoked in DI ending 1610 hrs. Market Notice 41962 was issued at 1611 hrs. The normally open 110 kV transmission link between Farrell and Burnie was closed at 1609 hrs in accordance with contingency plans¹, and the Farrell 220 kV buses isolated from each other, refer to Figure 1. In this configuration, the 110 kV network will be supplied from Burnie for the loss of Farrell – Sheffield No.1 and No.2 220 kV transmission lines, and generation at Farrell may be islanded.
- c. Simultaneous loss of George Town – Sheffield No.1 and No.2 220 kV transmission lines. Market Notice 41965 was issued at 1744 hrs. Constraint set T-GTSH_N-2 was invoked at 1745 hrs.

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.

¹ Prepared by Transend and agreed to by AEMO.

Figure 1- Pre-contingent system conditions prior to the incidents in Tasmania on 21 March 2013



2.2 Summary of events

At 1834 hrs 21 March 2013, the Farrell – Sheffield No.1 and No.2 220 kV transmission lines tripped out of service due to a fault associated with a lightning strike². The fault was cleared by protection within approximately 80 milliseconds.

As a result of the trips, generating units Reece Unit 2 (100 MW of generation) and John Butters (operating as a synchronous condenser) were islanded and therefore also tripped out of service. The Tasmanian Over-Frequency Generation Shedding Scheme (OFGSS) operated to open the circuit breakers at the Farrell end of the generator transmission lines³. Approximately 11 seconds after the fault was cleared Pacific Aluminium reduced in load by 118 MW, on potline No.4.

A summary of events is shown in Table 1.

Table 1: Sequence of events during incident: 1834 hrs 21 March 2013.

Time	Event
1834 hrs 21 March 2013	220 kV CB H152 at Farrell opens, due to lightning strike.
1834 hrs 21 March 2013	220 kV CB J152 at Farrell opens, due to lightning strike.
1834 hrs 21 March 2013	220 kV CB Y152 at Sheffield opens, due to lightning strike.. Farrell-Sheffield No.1 220 kV transmission line removed from service.
1834 hrs 21 March 2013	220 kV CB Z152 at Sheffield opens, due to lightning strike. Farrell-Sheffield No.2 220 kV transmission line removed from service.
1834 hrs 21 March 2013	220 kV CB B152 at Farrell opens due to operation of the OFGSS. John Butters unit disconnected from Farrell

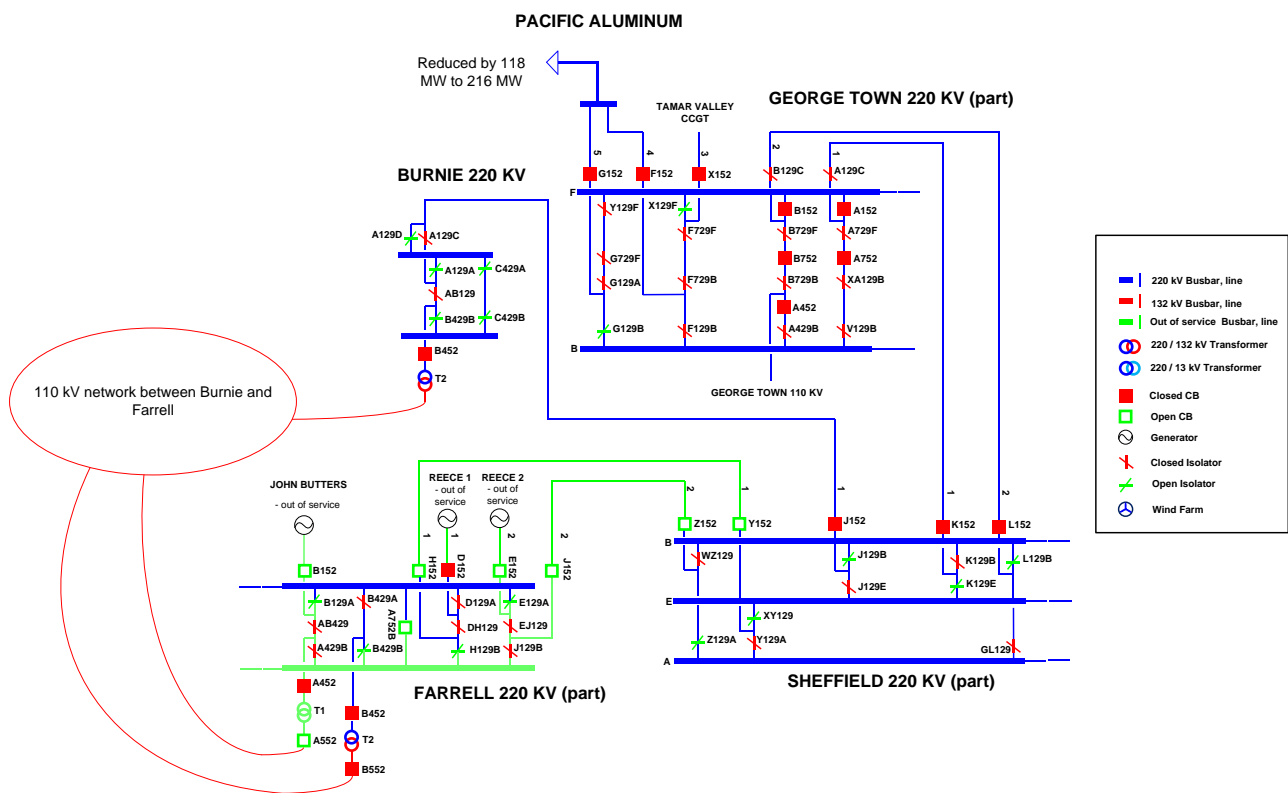
² Red phase and blue phase fault to ground on No.1 line. Three phase fault to ground on No.2 line.

³ The present configuration of the OFGSS is to trip line circuit breakers of generating units operating in synchronous condenser mode, in addition to generating units supplying active power.

Time	Event
1834 hrs 21 March 2013	220 kV CB E152 at Farrell opens due to operation of the OFGSS. Reece Unit 2 disconnected from Farrell 100 MW of generation lost.
1834 hrs 21 March 2013	Pacific Aluminium reduces in load by 118 MW.
1834 hrs 21 March 2013	220 kV CB B52 at Reece Unit 2 opens on operation of over-frequency protection.
1835 hrs 21 March 2013	220 kV CB 52 at John Butters opens, on relay indication of insufficient line current to sustain synchronous condenser mode.

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

Figure 2:- Status of the power system immediately after the incident 1834 hrs 21 March 2013.



2.3 Immediate actions taken

The Farrell – Sheffield No.1 and No.2 220 kV transmission lines were returned to service at 1846 hrs. Load restoration at Pacific Aluminium commenced at 1849 hrs. Generating units Reece Unit 2 and the John Butters were returned to service at 1953 hrs and 1957 hrs respectively.

AEMO issued Market Notice 41975 at 2036 hrs, advising the market of the incident. At 2049 hrs AEMO issued Market Notice 41977, advising the market that the loss of Farrell – Sheffield No.1 and No.2 transmission lines and Pacific Aluminium load had been re-classified as a credible contingency.

3 Incident in Tasmania at 1901 hrs 21 March 2013

3.1 Summary of events

At 1901 hrs 21 March 2013, the George Town - Sheffield No.2 220 kV transmission line tripped out of service due to a fault associated with a lightning strike⁴. The fault was cleared by protection within approximately 80 milliseconds.

Following fault clearance, both circuit breakers at the George Town end of the transmission line automatically reclosed. Approximately 11 seconds after the fault was cleared Pacific Aluminium reduced in load by 100 MW, on potline No. 3.

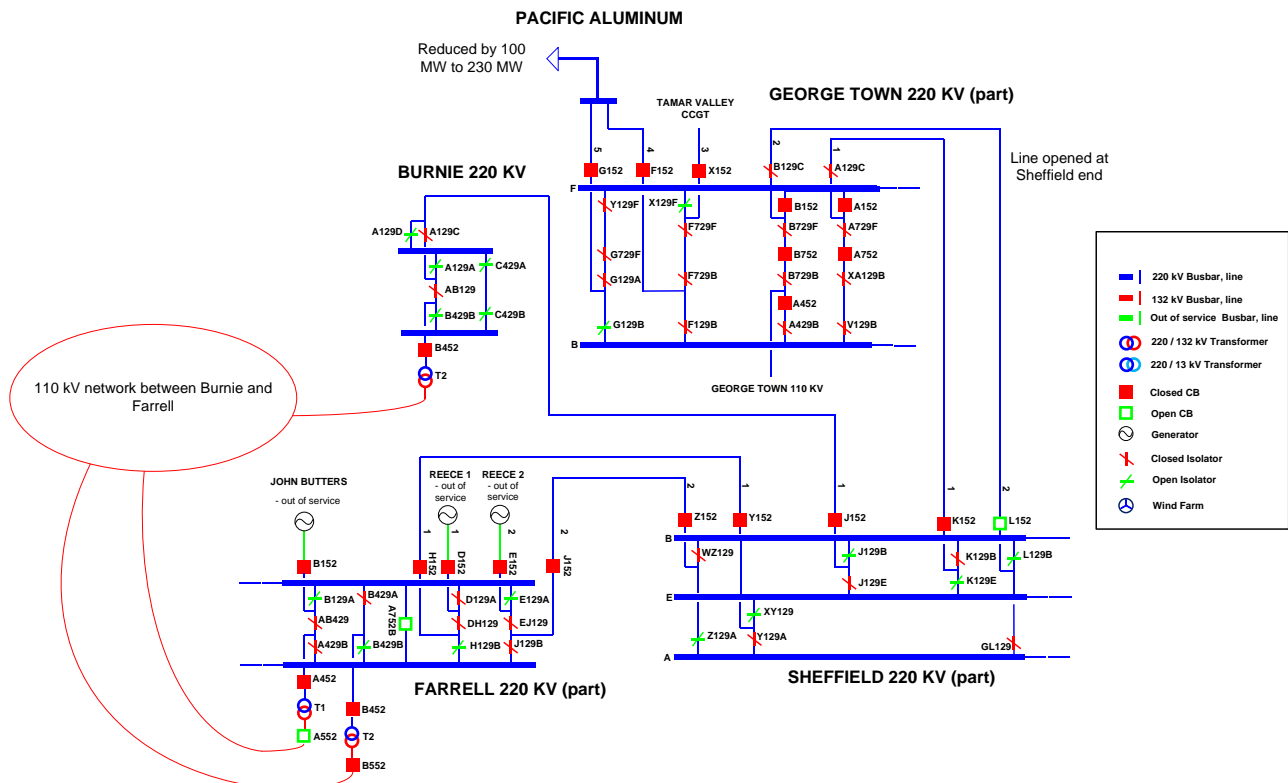
A summary of events is shown in Table 2.

Table 2: Sequence of events during incident: 1901 hrs 21 March 2013.

Time	Event
1901 hrs 21 March 2013	220 kV CB L152 at Sheffield opens.
1901 hrs 21 March 2013	220 kV CB B152 at George Town opens.
1901 hrs 21 March 2013	220 kV CB B752 at George Town opens. George Town - Sheffield No.2 220 kV transmission line removed from service.
1901 hrs 21 March 2013	220 kV CB B152 at George Town automatically recloses.
1901 hrs 21 March 2013	220 kV CB B752 at George Town automatically recloses.
1901 hrs 21 March 2013	Pacific Aluminium reduces in load by 100 MW.

The status of the power system immediately after the incident is shown in Figure 3.

Figure 3:- Status of the power system immediately after the incident 1901 hrs 21 March 2013.



⁴ Red phase fault to ground.

3.2 Immediate actions taken

The 220 kV CB L152 at Sheffield was manually closed at 1902 hrs, returning the George Town - Sheffield No.2 220 kV transmission line to service. Load restoration at Pacific Aluminium commenced at 1908 hrs.

At 2053 hrs AEMO issued Market Notice 41978, advising the market of the Incident. AEMO did not issue a market notice reclassifying the George Town – Sheffield No.2 220 kV transmission line and Pacific Aluminium; the incident happened a second time (Section 4 of this report) before AEMO had completed assessing this incident.

4 Incident in Tasmania at 2057 hrs 21 March 2013

4.1 Summary of events

At 2057 hrs 21 March 2013, the George Town - Sheffield No.2 220 kV transmission line tripped out of service due to a fault associated with a lightning strike⁵. The fault was cleared by protection within approximately 80 milliseconds.

While the fault was being cleared, Pacific Aluminium reduced in load by 119 MW on potline No. 4. Approximately 1 second after the fault was cleared Pacific Aluminium reduced in load by 102 MW, on potline No. 3.

A summary of events is shown in Table 3.

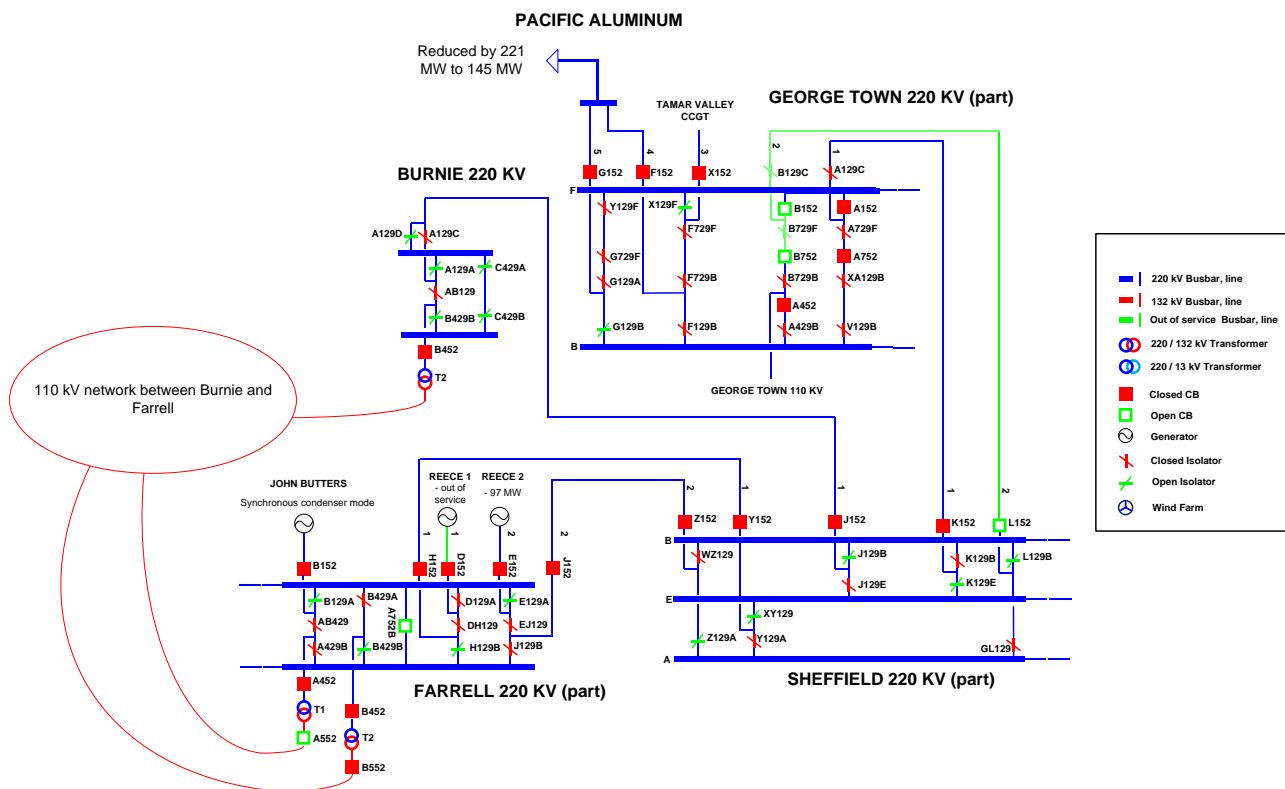
Table 3: Sequence of events during incident: 2057 hrs 21 March 2013.

Time	Event
2057 hrs 21 March 2013	220 kV CB L152 at Sheffield opens.
2057 hrs 21 March 2013	220 kV CB B152 at George Town trips to lockout.
2057 hrs 21 March 2013	220 kV CB B752 at George Town trips to lockout.
2057 hrs 21 March 2013	Pacific Aluminium reduces in load by 119 MW.
2057 hrs 21 March 2013	Pacific Aluminium reduces in load by 102 MW.

The status of the power system immediately after the incident is shown in Figure 4.

⁵ Red phase and blue phase fault to ground.

Figure 4:- Status of the power system immediately after the incident 2057 hrs 21 March 2013.



4.2 Immediate actions taken

An attempt was made to re-energise the George Town - Sheffield No.2 220 kV transmission line via 220 kV CB L152 at Sheffield. 220 kV CB L152 at Sheffield tripped approximately six seconds later and the transmission line remained out of service until the line was patrolled.

At 2103 hrs AEMO issued Market Notice 41981, advising the market of the incident. Constraint set T-GTSH was invoked in DI ending 2105 hrs.

Restoration of load at Pacific Aluminium commenced at 2115 hrs. At 2141 hrs AEMO issued Market Notice 41984, advising the market that the loss of George Town – Sheffield No.2 220 kV transmission line and Pacific Aluminium load had been re-classified as a credible contingency.

5 Follow-up Actions

Transend patrolled the George Town - Sheffield No.2 220 kV transmission line on the morning of 22 March 2013. The George Town - Sheffield No.2 220 kV transmission line was returned to service 1227 hrs 22 March 2013. Constraint set T-GTSH was revoked at 1335 hrs 22 March 2013.

Pacific Aluminium investigated the three load reductions of their potlines. The load reduction at 1834 hrs 21 March 2013 was determined to be due to a relay operating on phase asymmetry protection. The phase asymmetry relay function was subsequently disabled by Pacific Aluminium.

The load reductions at 1901 hrs and 2057 hrs were due to emergency shutdown relays at Pacific Aluminium operating as a result of the voltage drop during the fault. The emergency shutdown relays are supplied by battery banks. The battery banks are supplied by battery chargers; and the battery chargers tripped during the fault. Due to the age of the battery banks, when the battery chargers tripped the DC voltage supplying the emergency shutdown relays dropped to a level seen as loss of voltage to the relays. The fail-safe design of the emergency shutdown relays tripped the potlines.

The battery banks supplying the emergency shutdown relays have subsequently been replaced by Pacific Aluminium. On 9 April 2013, AEMO issued Market Notices 42118 and 42119, advising the market that the reclassifications associated with Pacific Aluminium had been cancelled.

6 Power System Security Assessment

The post-contingent system voltages and frequencies remained within the normal operating bands and the power system remained in a secure operating state throughout each incident. The control of the Tasmanian frequency was consistent with the Tasmania Frequency Operating Standard.

The fault clearance times on each transmission line trip was consistent with the NER. The load reductions at Pacific Aluminium were consistent with the NER as load is not required to ride through system disturbances.

The provision and response of facilities was adequate to maintain power system security.

7 Conclusions

The trip of the transmission lines in Tasmania at 1834 hrs, 1901 hrs and 2057 hrs 21 March 2013 were caused by lightning strikes. The consequent load reductions at Pacific Aluminium in response to these faults were caused by plant protection operation; and operation of emergency shutdown systems failing safe due to loss of supply during the fault.

AEMO is satisfied that Pacific Aluminium has carried out the appropriate work to mitigate the risk of a similar incident occurring in the future.

AEMO correctly applied the criteria published in section 13 of its Power System Security Guidelines in assessing that the circumstances of these incidents warranted reclassifying similar incidents as a credible contingency event.

8 Recommendations

There are no recommendations arising from this incident.