POWER SYSTEM INSECURE IN QUEENSLAND ON 13 OCTOBER 2015

AN AEMO POWER SYSTEM OPERATING INCIDENT REPORT FOR THE NATIONAL ELECTRICITY MARKET

Published: **July 2016**

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	0538 hrs Tuesday 13 October 2015
Region of incident	Queensland
Affected regions	Queensland
Event type	Power System not in a secure operating state for longer than 30 minutes
Generation Impact	No generator was disconnected as a result of this incident
Customer Load Impact	No customer load was disconnected as a result of this incident
Associated reports	Direction to north Queensland Generators on 13 October 2015

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator
CA	Real time contingency analysis
kV	Kilovolt
Line 7130/1	Clare South - Townsville South 7130/1 132 kV line
Line 7131	Clare South - Townsville South 7131 132 kV line
Line 879	Ross - Strathmore 879 275 kV line
Line 8857	Ross - Strathmore 8857 275 kV line
Line 8858	Ross - Strathmore 8858 275 kV line
MW	Megawatt
NER	National Electricity Rules

IMPORTANT NOTICE

Purpose

AEMO has prepared this report in accordance with clause 4.8.15(c) of the National Electricity Rules, using information available as at the date of publication, unless otherwise specified.

Disclaimer

AEMO has made every effort to ensure the quality of the information in this report but cannot guarantee its accuracy or completeness. Any views expressed in this report are those of AEMO unless otherwise stated, and may be based on information given to AEMO by other persons.

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1. OVERVIEW

This report relates to a reviewable operating incident[1] that occurred on Tuesday 13 October 2015 involving the 275 kV transmission lines between Ross and Strathmore in Queensland. At the time of the incident, the Ross - Strathmore 8857 275 kV transmission line (Line 8857) was out of service on a planned outage. There was no loss of generation or customer load as a result of this incident.

This incident involved:

1. Multiple unplanned outages of the Ross - Strathmore 879 275 kV line (Line 879).
2. The simultaneous outage of the Ross – Strathmore 879 and 8858 275kV transmission lines was reclassified as a single credible contingency event.
3. Directions to some north Queensland generating units to restore power system security.

As a reviewable operating incident, AEMO is required to assess power system security over the course of this incident, and 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.[2]

AEMO concluded that:

1. The unplanned outages of Line 879 were caused by insulation breakdown, which was initiated by a combination of aberrant insulator pollution, high humidity and low wind conditions.
2. The power system was not in a secure operating state for 135 minutes. AEMO was unable to return the power system to a secure operating state within 30 minutes.
3. The delay in restoring the power system to a secure operating state was due to
    - The temporary withdrawal of some generation capacity in north Queensland from the market due to uneconomic dispatch targets resulting from constraint action.
    - Communication issues between AEMO and Powerlink in implementing contingency plans.
    - The failure or unexpected delays of some generating units in response to directions.
4. There were some delays and omissions in the provision of information and notices to participants.

This report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It is based on information provided by Powerlink[3] and AEMO. National Electricity Market time (Australian Eastern Standard Time) is used in this report.

2. THE INCIDENT

On Tuesday 13 October 2015, Line 8857 was on a planned outage and constraint set Q-SMRS[4] was invoked.

Between 0538 hrs and 0640 hrs, Line 879 tripped four times, successfully auto-reclosing twice at 0538 hrs and 0622 hrs and locking out on the other two occasions.

Regarding the two lockouts

- At 0603 hrs, Line 879 tripped and locked out. The line was returned to service at 0621 hrs.

[1] See NER clause 4.8.15(a)(1)(i), as the event relates to a non-credible contingency event; and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.
[2] See NER clause 4.8.15(b).
[3] Powerlink is the transmission network service provider in Queensland.
[4] Voltage stability limits for the outage of either 879, 8857 or 8858 line.

- At 0640 hrs, Line 879 tripped and remained out of service. As this was the second trip and lock-out within a short timeframe, AEMO invoked constraint set Q-X_SMRS_A[5] at 0645 hrs to manage power system security. Line 879 was returned to service at 0702 hrs.

On the basis of the number of line trips over a short period and because the cause of the line trips was not known, AEMO reclassified the simultaneous loss of Line 879 and Line 8858 as a credible contingency event. Constraint set Q-X_SMRS_A remained invoked to manage the reclassification. Constraint equation Q_RS_260 within this constraint set requires the flow on the Ross cut-set[6] to be reduced to 260MW. This constraint was violating, indicating that the power system was not in a secure operating state. This is discussed further in Section 4.

Refer to Appendix A for the system diagram at the beginning of the incident, and Appendix B for a chronological log of the incident.

3. POWERLINK REVIEW

Powerlink, the Transmission Network Service Provider (TNSP) for Queensland, provided the following information.

The multiple trips of 275kV Line 879 during the incident were due to insulation breakdown of the line insulators. The breakdown was a result of aberrant insulator pollution combined with high humidity and low wind conditions on the day of the event.

Powerlink has replaced the insulators that were damaged as a result of the event and carried out insulator washing in the affected areas.

4. POWER SYSTEM SECURITY

This section assesses how AEMO managed power system security over the course of this incident.[7]

AEMO is responsible for maintaining the NEM power system in a secure operating state, subject to the power system security principles in NER clause 4.2.6.

During the course of this incident, the power system was not in a secure operating state for 135 minutes.

At 0603hrs when Line 879 tripped and locked out for the first time, AEMO did not invoke any constraint sets because Powerlink had advised a reclose attempt would be made in accordance with its procedures[8]. AEMO's response is considered appropriate given that it takes at least ten minutes to invoke a constraint set and have it active in dispatch.

At 0640 hrs, Line 879 tripped and remained out of service. Constraint set Q-X_SMRS_A was invoked at 0645 hrs to manage post-contingent voltages and thermal loading on the parallel 132 kV networks should the remaining Ross - Strathmore 275 kV line trip. This constraint set contains constraint equation Q_RS_260 which limits flows on the Ross cut-set to 260 MW. The constraint equation violated immediately due to insufficient generation being made available in north Queensland to reduce Ross cut-set flow to the required level. A number of generating units in north Queensland received targets to synchronise. However, several generating units rebid themselves unavailable on the basis that dispatch was uneconomical. The constraint violation meant the power system in north Queensland was not in a secure operating state.

[5] Voltage stability limits for outage of any two 275kV lines between Ross and Strathmore. Sets Ross cut-set flow to an upper limit of 260MW.
[6] The Ross cut-set is defined by the three 275 kV lines from Ross to Strathmore, 132 kV line from Strathmore to Clare South, and 132 kV from Clare South to King Creek.
[7] AEMO is responsible for power system security in the NEM and is required to operate the power system in a secure operating state (NER Clause 4.2.4 (a)). AEMO must thereby ensure that the power system is maintained in, or returned to, a secure operating state following a contingency event.
[8] It is standard practice by Powerlink that a manual reclose is normally attempted after 15 minutes following a failure of an auto-reclose event.

As part of the outage planning process for the Line 8857 outage, Powerlink had provided a contingency plan to restore the power system to a secure operating state if another line between Ross and Strathmore tripped and a generation solution was not available (refer to Appendix C).Part of this contingency plan implements a strategy to ensure controlled splitting of the parallel 132kV network if the 275kV connections are lost. This controlled splitting is required to prevent post contingent overload and voltage collapse. At 0657 hrs, AEMO asked Powerlink to implement this part of the contingency plan. Powerlink confirmed that it would implement this part of the contingency plan and would advise AEMO when this was done.

At 0702 hrs, on the return to service of Line 879, AEMO reclassified the simultaneous loss of Lines 879 and 8858 as a credible contingency event. This reclassification decision was based on the fact that Line 879 had tripped four times and Powerlink was in the process of determining the root cause. The 260 MW limit on the Ross cut-set flow remained in place as a result of this reclassification. Constraint equation Q_RS_260 continued violating and the power system in north Queensland remained in an insecure operating state. No action was taken by AEMO at this stage as AEMO expected that implementation of the part of Powerlink's contingency plan to prepare the network to split would return the power system to a secure operating state.

However, at 0715 hrs, Powerlink advised AEMO that

- It was not implementing the part of the contingency plan to prepare the network to split as this would put customer load at risk and reliability of supply was Powerlink's priority.
- If there was insufficient generation available via market outcome or direction then Powerlink would implement this part of the contingency plan and place load at risk.

Based on this advice AEMO considered the contingency plan was no longer an option to restore system security, and determined that the only reasonable option available was to issue directions[9] to generation in north Queensland. AEMO contacted generation participants in north Queensland to determine their ability to respond to a direction.

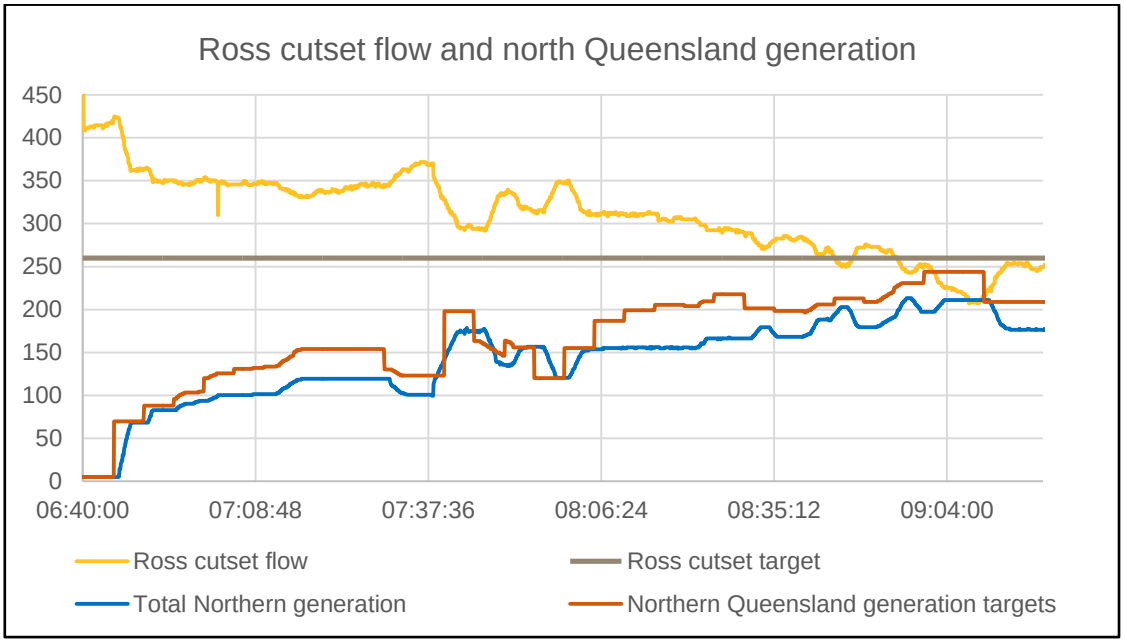
From 0740 hrs, AEMO issued four directions to generating units to synchronise and follow dispatch targets in north Queensland. Several unexpected delays occurred during the direction process due to:

- Two generating units being unable to synchronise and follow dispatch targets.
- About 20 minutes extra delay to its normal fast start profile for one generating unit to synchronise and follow targets.

At 0855 hrs, about 85 minutes after issuing the first Direction, the Ross cut-set flow was reduced to 260 MW and power system in north Queensland returned to a secure operating state. The power system was not in a secure operating state for 135 minutes. Figure 1 details the Ross cut-set flow and generation response during this time. Appendix D provides information on the response of individual generating units to the directions.

[9] As per clause 4.8.9 or the NER.

Figure 1 – Ross cut-set flow



At 0908 hrs, Powerlink advised that the trip of the 879 Line was due to a combination of insulator pollution, high humidity and low wind conditions. As the contributing weather conditions had dissipated, there was no further expectation of the line tripping.

At 0920 hrs, AEMO cancelled the reclassification and all directions were cancelled at 0930hrs.

For this incident AEMO did not return the power system to a secure operating state within 30 minutes. This was due to a combination of:

- A number of generating units temporarily withdrawing capacity from the market in response to constraint action.
- Communication issues between AEMO and Powerlink in relation to implementation of an agreed contingency plan.
- Unexpected delays in directed generating units synchronising and following dispatch targets.

Although the power system was not in a secure operating state for longer than 30 minutes, AEMO considers that it took all reasonable action available to it, given the alternative option was to instruct Network Service Providers (NSPs) in north Queensland to shed customer load. AEMO did not issue instructions to shed customer load.

Powerlink and AEMO's outage assessment teams have since discussed and agreed on how contingency plans should be written and the implementation conditions that would avoid confusion in similar situations.

Although not discussed by AEMO and Powerlink at the time, Powerlink has subsequently advised AEMO that it would be willing to put load at risk, as part of an overall contingency plan, as a short term solution while AEMO implements a generation solution.

Directed participants who experienced unexpected delays during the direction process have provided AEMO with explanations of these delays as required by the NER[10].

Further details on the directions issued by AEMO are available in the Direction Report.[11]

[10] Refer to clause 4.8.9(e)
[11] Available on the AEMO website at: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Reports-on-Directions

5. MARKET INFORMATION

AEMO is required by the NER and operating procedures to inform the market about incidents as they progress. This section assesses how AEMO informed the market[12] over the course of this incident.

For this incident, AEMO was required to inform the market on the following matters:

1. A reclassification or cancellation of reclassification of contingency events – notify as soon as is practicable.[13]

   Between 0737hrs and 0925hrs AEMO issued Market Notices 50011, 50012 and 50021 to advise the market of issues surrounding Line 879. Although AEMO reclassified the loss of both Line 879 and Line 8858 as a credible contingency at 0702hrs, this was not made clear to the market until Market Notice 50021 was issued, five minutes after the reclassification was cancelled.

   AEMO issued Market Notice 50023 at 1005 hrs to notify the market that AEMO had cancelled the reclassification at 0920 hrs – 45 minutes after the cancellation.

2. Directions issued or revoked by AEMO[14]

   AEMO issued Market Notice 50022 at 0949 hrs to notify the market that AEMO had issued Directions to participants from 0740 hrs in the Queensland region to maintain power system security – about two hours after the first Direction.

   AEMO issued Market Notice 50034 at 0042 hrs (on 14/10/2015) to notify the market that AEMO had cancelled the Directions in Queensland region at 0930 hrs on 13/10/2015 – about 15 hours after Directions were cancelled.

   When AEMO issues a direction, it is required to advise the market as soon as possible whether intervention pricing[15] will be triggered. AEMO failed to advise the market in relation to intervention pricing.

Although there are no specific time frames required for AEMO to advise the market, AEMO has taken steps to ensure information is provided in a more timely and accurate manner. AEMO has updated its internal procedures and routine operator training sessions now include greater emphasis on provision of accurate and timely market advice.

6. CONCLUSIONS

AEMO has assessed this incident in accordance with clause 4.8.15(b) of the NER. In particular, AEMO has assessed the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.

AEMO has concluded that:

1. The unplanned outages of Line 879 were caused by insulation breakdown, which was initiated by a combination of aberrant insulator pollution, high humidity and low wind conditions.
   - The insulators damaged as a result of the event have since been replaced and all insulators in the affected areas washed.
2. The power system was not in a secure operating state for 135 minutes. AEMO was unable to return the power system to a secure operating state within 30 minutes.

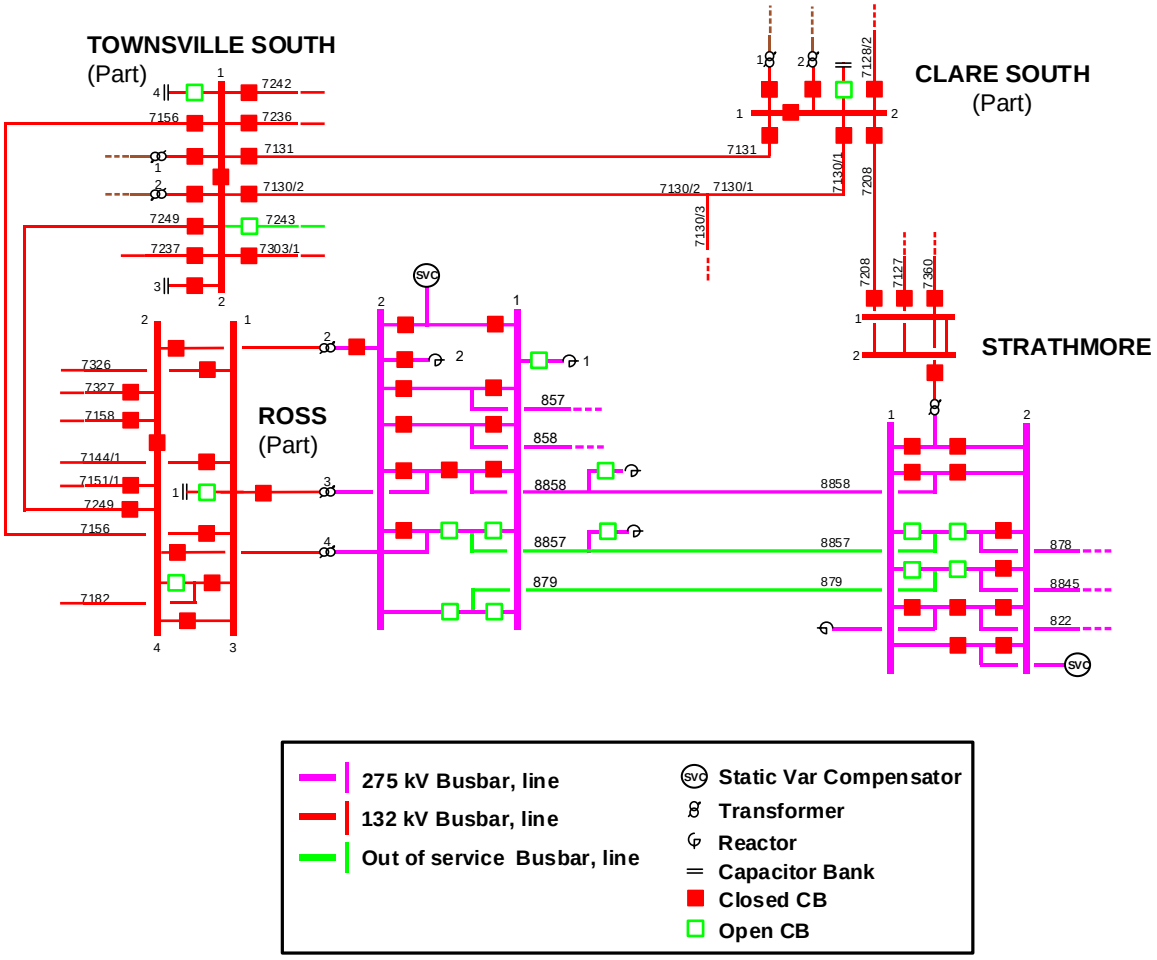
[12] AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see AEMO website
[13] AEMO is required to notify the market of a reclassification and cancellation of reclassification of contingency events as soon as is practicable – Refer to AEMO procedure SO_OP3715, *Power System Security Guidelines,* Section 11.
[14] AEMO is required to notify the market that AEMO has issued a Direction as soon as possible after issuing the direction Refer to AEMO procedure SO_OP 3707 *Intervention, Direction and Clause 4.8.9 Instructions*.
[15] Refer to clause 3.9.3 of the NER

3. The delay in restoring the power system to a secure operating state was due to
    - The temporary withdrawal of some generation capacity in north Queensland from the market due to uneconomic dispatch targets resulting from constraint action.
    - Communication issues between AEMO and Powerlink in implementing contingency plans.
    - The failure or unexpected delays of some generating units in response to directions.

    AEMO's actions to restore the power system to a secure operating state are considered as reasonable.
4. There were some delays and omissions in the provision of information and notices to participants.
    - AEMO's internal procedures have been updated to address this issue.

APPENDIX A. POWER SYSTEM DIAGRAM

The power system immediately after the trip of Line 879.



APPENDIX B. INCIDENT EVENT LOG

Chronological Log of Incident

Time and Date	Event
13/10/2015 0538 hrs	Line 879 tripped and auto reclosed.
13/10/2015 0603 hrs	Line 879 tripped and locked out.
13/10/2015 0621 hrs	Line 879 returned to service.
13/10/2015 0622 hrs	Line 879 tripped and auto reclosed.
13/10/2015 0640 hrs	Line 879 tripped and locked out.
13/10/2015 0645 hrs	AEMO invoked constraint set Q-X_SMRS_A.
13/10/2015 0657 hrs	Powerlink advised AEMO they would implement the agreed Contingency Plan
13/10/2015 0702 hrs	Line 879 returned to service. AEMO reclassified the loss of Lines 879 and 8858 as credible contingency.
13/10/2015 0715 hrs	Powerlink advised AEMO that they would not be implementing the contingency plan until all generation options including directions had been exhausted.
13/10/2015 0740 hrs	AEMO directed north Queensland unit 1 to synchronise and follow dispatch targets.
13/10/2015 0737 hrs	AEMO issued MN 50011: notification of Line 879 reclassified as a credible contingency.
13/10/2015 0752 hrs	AEMO issued MN 50012 (correction to MN 50011)
13/10/2015 0810 hrs	AEMO directed north Queensland units 2 and 3 to synchronise and follow dispatch targets.
13/10/2015 0830 hrs	Direction to North Queensland units 2 and 3 cancelled as unable to follow Direction
13/10/2015 0835 hrs	AEMO directed north Queensland unit 4 to synchronise and follow dispatch targets.
13/10/2015 0840 hrs	AEMO directed north Queensland unit 5 to synchronise and follow dispatch targets.
13/10/2015 0855 hrs	Power system returned to a secure operating state with Ross cut-set flow reduced to 260 MW.
13/10/2015 0908 hrs	Powerlink advised AEMO that the cause of the trips of 879 Line had been identified and there were no further expectations of the line tripping due to that cause.
13/10/2015 0920 hrs	AEMO cancelled the reclassification and revoked constraint set Q-X_SMRS_A.
13/10/2015 0925 hrs	AEMO issued MN 50021 (further correction to MN 50011)
13/10/2015 0930 hrs	AEMO revoked all Direction constraints for north Queensland generation.
13/10/2015 0949 hrs	AEMO issued MN 50022: notification that a number of Directions were issued in Queensland region to maintain system security.
13/10/2015 1005 hrs	AEMO issued MN 50023: notification that the reclassification had been cancelled.
14/10/2015 0042 hrs	AEMO issued MN 50034: notification that all Directions in Queensland region had been cancelled.

APPENDIX C. POWERLINK'S CONTINGENCY PLAN FOR PLANNED OUTAGE OF LINE 8857

Loss of feeder 8858 or 879:

System lands in satisfactory state (suggest switching out bus reactor at H013 Ross to restore SVC range):

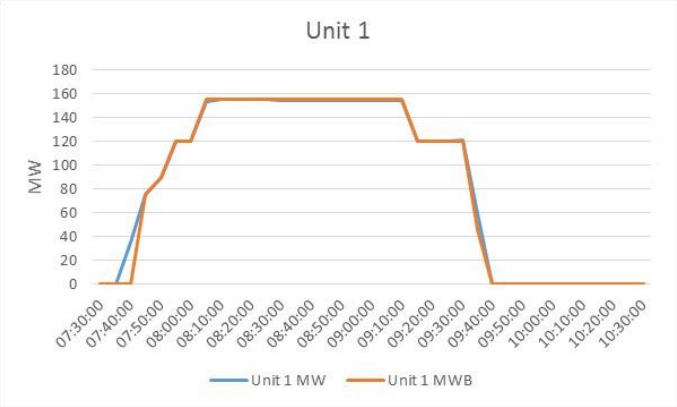
- To re-secure (for loss of last 275kV feeder):
  - AEMO to apply constraint equation Q-RS_260

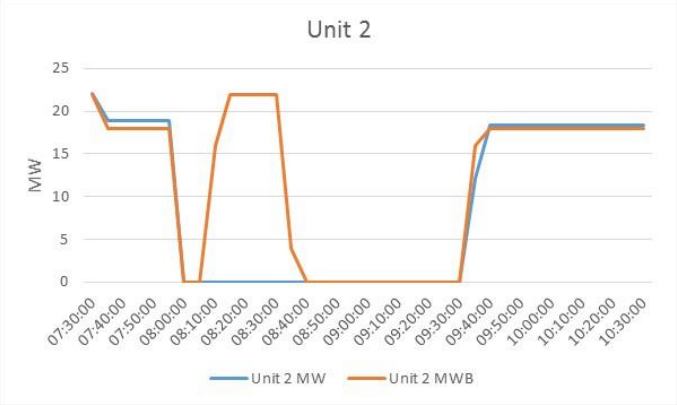
    This is to maintain post-contingent voltages and manage the post contingent thermal transfer on feeders 7130 and 7131.

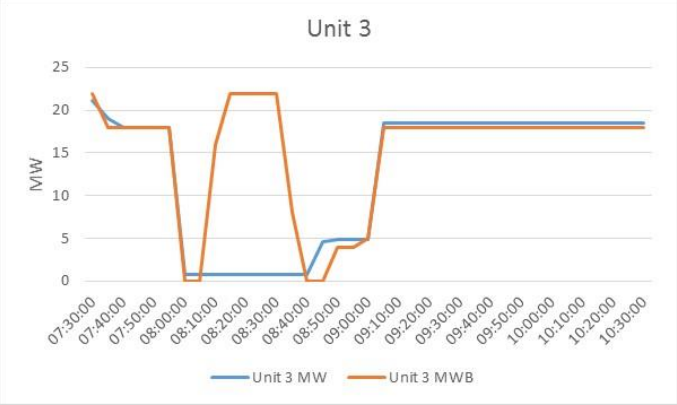
    (AEMO equation includes 10MW Operating Margin, so actually targets 250MW).
- If insufficient generation available, prepare network to split between T193 Clare South and T056 Townsville South:
  - Invoke Overcurrent settings on both Feeders 7130/1 & 7131 = 550Amps (110MVA) for 0.8seconds, (Permits 1999 & 2001).
  - Liaise with Ergon to radialise their 66kV network. Ergon preference is to:
    - Prepare cap bank support at T095 Millchester
    - Deload Feeder 7182 (H013 Ross to T095 Millchester), suggest at H013 Ross
    - Open 66kV CB A152 at Charters Towers
    - Ergon to manage loading on 66kV network
  - Advise Ergon & Manager NOS that all Ross + Far North Queensland load is at risk

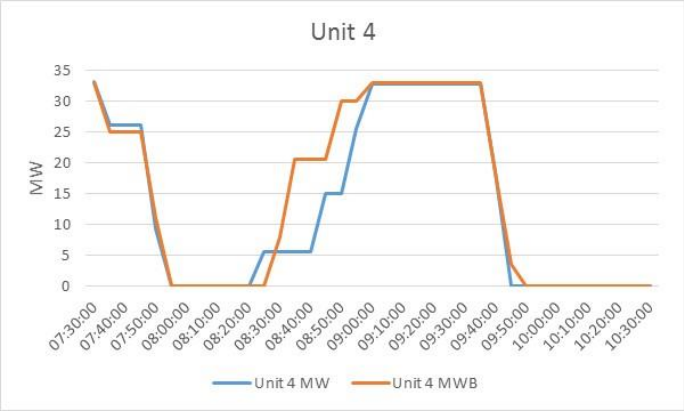
APPENDIX D. – GENERATION RESPONSE TO DIRECTIONS

The following charts provide details of the response of individual generating units to the Directions issued by AEMO. Unit MW is the output of the generating unit and MWB is the dispatch target from AEMO's market system.








Unit 4
MW
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07:40:00
07:50:00
08:00:00
08:10:00
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09:20:00
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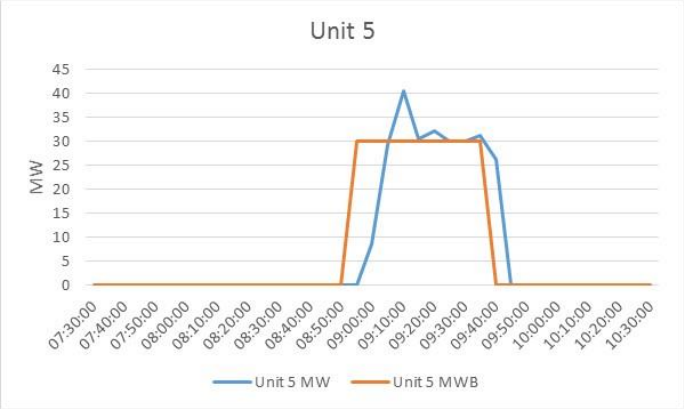
Unit 4 MW
Unit 4 MWB


Unit 5
MW
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Unit 5 MW
Unit 5 MWB