POWER SYSTEM NOT IN A SECURE OPERATING STATE IN VICTORIA ON 15 JUNE 2016

REVIEWABLE OPERATING INCIDENT REPORT UNDER THE NATIONAL ELECTRICITY RULES

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1111 hrs 15 June 2016
Region of incident	Victoria
Affected regions	Victoria
Event type	Power system not secure
Generation Impact	No generator was disconnected or limited as a result of this incident
Customer Load Impact	No customer load was disconnected as a result of this incident
Associated reports	Nil

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator
CB	Circuit Breaker
kV	Kilovolt
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

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1. OVERVIEW

This report relates to a reviewable operating incident[1] that occurred on 15 June 2016 in the Victoria region. During this incident, the power system in Victoria was not in a secure operating state for greater than 30 minutes due to high voltage levels at Moorabool substation.

No customer load or generation was lost as a result of this incident.

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 has concluded that:

1. The power system was not in a secure operating state for 174 minutes.
2. The cause of the incident was a combination of an unusual transmission system configuration and unexpected difficulties in managing the MVAr output of Mt Mercer wind farm.
3. The delay in restoring the power system to a secure operating state was related to difficulties experienced in reducing the MVAr output from Mt Mercer wind farm.

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 Meridian Energy[3] and AEMO.

Australian Eastern Standard Time is used in this report.

2. THE INCIDENT

At 1111 hrs on 15 June 2016, the Moorabool – Elaine – Ballarat 220kV transmission line (MLTS-ELTS-BATS line) was re-energised from the BATS end following a planned outage[4]. Due to unexpected delays associated with the work on the circuit breaker at the MLTS end this circuit breaker remained open.

From 1112 hrs, AEMO's on line contingency analysis (CA) tools indicated that, for the loss of the Ballarat – Moorabool 220kV line (BATS-MLTS line), voltage levels on the MLTS end of the MLTS-ELTS-BATS line would exceed acceptable limits. This meant the power system was not in a secure operating state.

At around 1130 hrs, in accordance with switching instructions from Transmission Operations Australia (TOA)[5], as part of the process for returning the MLTS-ELTS-BATS line to service, the Mt Mercer wind farm reconnected to the MLTS-ELTS-BATS line at ELTS, generating around 8 MW and 28 MVAr. This increased the potential for voltage violations at MLTS. AEMO took a number of actions in an attempt to reduce voltage levels on the MLTS-ELTS line and restore the power system to a secure operating state. As these actions were not successful, AEMO then instructed AusNet Services to de-energise the MLTS-ELTS section of the MLTS-ELTS-BATS line. These actions are explained further in Section 3. The power system was restored to a secure operating state at 1406 hrs on 15 June 2016.

The MLTS-ELTS line section and the circuit breaker at MLTS were restored to service at 1530 hrs on 16 June 2016.

The reason for investigating this incident is that the power system was not in a secure operating state for greater than 30 minutes.

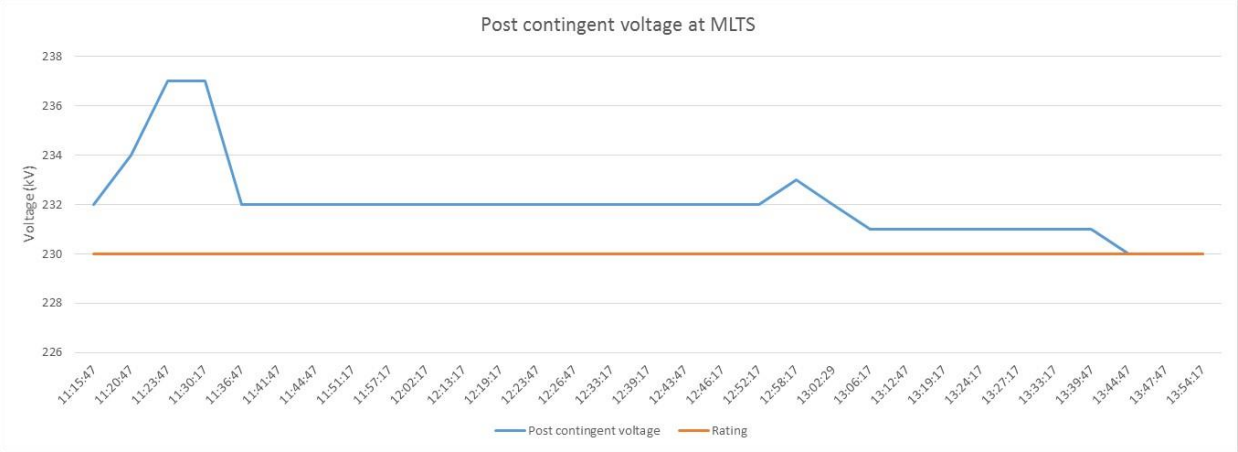
[1] See NER clause 4.8.15(a)(1)(i), as the event relates to a non-credible contingency event; and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.
[2] See NER clause 4.8.15(b).
[3] As the owner/operator of Mt Mercer wind farm.
[4] This outage was for two separate jobs. One job was to work on the transmission line and a separate job to work on the circuit breaker at MLTS.
[5] Toa is the owner/operator of the Elaine Terminal station and the 132kV transmission line to Mt Mercer WF.

3. POWER SYSTEM SECURITY

AEMO is responsible for power system security in the NEM. This means AEMO is required to operate the power system in a secure operating state and return the power system to a secure state following a contingency event. This section assesses how AEMO managed power system security over the course of this incident[6].

When the MLTS-ELTS-BATS line was energised from BATS, AEMOs Contingency Analysis (CA) tools immediately showed post contingent voltage violations at the MLTS end of the line[7]. This was then exacerbated when the Mt Mercer wind farm reconnected to the power system. Although CA showed violations for a number of potential contingencies[8], the most severe violations would occur with the loss of the BATS-MLTS line. Figure 1 shows the voltage levels that would have occurred at MLTS if the BATS-MLTS line had tripped. The maximum allowable voltage at MLTS is 230kV.

Figure1: Voltage violations at MLTS



AEMO has recently commissioned an automated voltage control tool, the VAr Dispatch Scheduler (VDS). This tool ran at 1126 hrs, and issued a number of voltage control actions to resolve the high voltage issue at MLTS. All voltage control actions had been completed by 1135 hrs and would have resolved the voltage issue had the power system conditions not changed. However at 1130 hrs the Mt Mercer wind farm reconnected to the power system generating 28 MVAr[9]. This resulted in continued post contingent voltage violations at MLTS. The VDS ran again at 1148hrs but AEMO considered the resulting actions were not valid[10] and decided to revert to manual voltage control. After discussion with AusNet Services, AEMO determined the preferred solution was to reduce the MVAr output from Mt Mercer[11] as this did not require any further line switching and was expected to be easy to implement.

Between 1209 hrs and 1318 hrs, AEMO had a number of conversations with Mt Mercer and TOA with a view to reducing the MVAr output from Mt Mercer. Due to limitations in procedures at AEMO and Mt Mercer, there was no clear view as to how this could be achieved. There are two 20 MVAr capacitor/filters installed at Mt Mercer and AEMO's procedures were unclear as to whether these could be switched out of service. At 1227 hrs, AEMO requested Mt Mercer to reduce the MVAr output to as close to zero as possible. The method of achieving this was at the discretion of Mt Mercer. The wind farm operator then switched both capacitor/filters out of service. However the turbine control system then increased the reactive output from each of the turbines to compensate, resulting in little change in the overall reactive output from the wind farm. The wind farm operator then switched 14 turbines off in a further attempt to reduce the MVAr output from the wind farm.

[6] 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.
[7] For a transmission line that is energised but open at one end the voltage levels at the open end will be higher than at the closed end due to the Ferranti effect.
[8] Refer to Appendix B for a complete list of contingencies and associated voltage violations.
[9] The Mt Mercer WF is connected to the power system at ELTS.
[10] As the VDS recommended a large number of very small changes that were not practical to implement.
[11] Other potential solutions included disconnecting the Mt Mercer wind farm or de-energising the MLTS-ELTs section of the MLTS-ELTS-BATS line.

Between 1318 hrs and 1335 hrs, a number of discussions were held between AEMO, Mt Mercer, TOA and AusNet to try to determine what reactive control mode the wind farm was in and what the interaction was between the reactive output of the individual turbines, the capacitor/filter banks and the 132/33kV transformer tap changer. All were with a view to reducing the MVAr output from Mt Mercer. These attempts were unsuccessful and the potential for post contingent voltage violations at MLTS remained.

AEMO then determined that the only remaining option to resolve the voltage issue and return the power system to secure operating state was to de-energise the MLTS-ELTS section of the MLTS-ELTS-BATS line. At 1335 hrs AEMO instructed AusNet to de-energise the MLTS-ELTS line[12]. The line was de-energised and the power system returned to a secure operating state at 1406 hrs. The power system was not in a secure operating state for 174 minutes.

3.1 Follow-up

Advice received from Mt Mercer has confirmed that the wind farm operates in voltage control mode in accordance with its Generator Performance Standard (GPS) and as a result the wind farm operators were expecting voltage control instructions from AEMO to be in the form of specified voltage levels rather than MVAr output[13]. Mt Mercer has reviewed its internal procedures and updated advice to the Mt Mercer operators regarding similar future requests in relation to voltage control actions. This is expected to reduce the likelihood of this problem happening again.

Subsequent to this event AEMO has noted that the operation of Mt Mercer was in accordance with its GPS, and operation at a lower level of MVAr output would have been outside the requirements of the GPS. As a result of this incident AEMO is taking the following actions:

- Conducting a review of the GPS for Mt Mercer to determine if operation at zero MVAr output at low MW output can be allowed.
- Revising AEMO internal procedures relating to voltage control at Mt Mercer in particular and all wind farms in general.
- Updating the displays on the AEMO Energy Management System (EMS) to provide additional voltage information to the control room in relation to Mt Mercer. This action has been completed.

4. 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 power system was not in a secure operating state for 174 minutes.
2. The cause of the incident was a combination of an unusual transmission system configuration and unexpected difficulties in managing the MVAr output of Mt Mercer wind farm.
3. The delay in restoring the power system to a secure operating state was related to difficulties experienced in reducing the MVAr output from Mt Mercer wind farm.

[12] Due to the switchgear arrangements at ELTS this required the outage of the BATS-ELTS line as part of the switching sequence. Refer to appendix A.
[13] AEMO may issue instructions in terms of a specific voltage levels, change in voltage levels, a specific MVAr output or change in MVAr output.

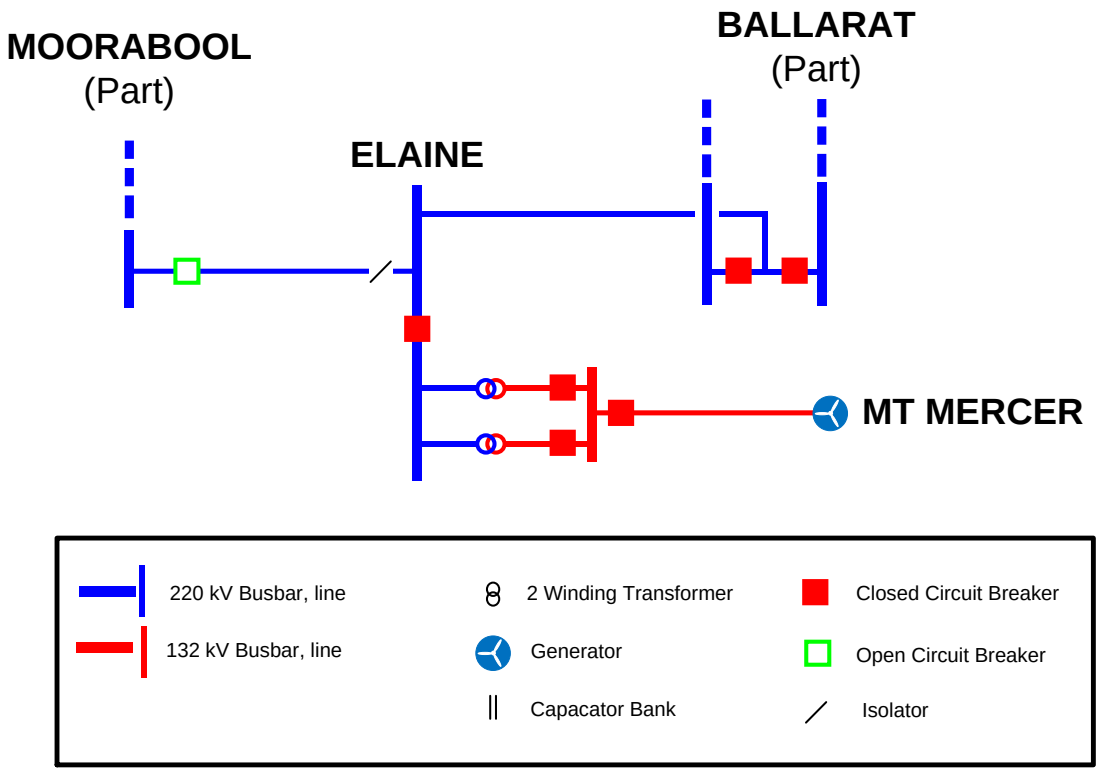
5. PENDING ACTIONS

The following actions are yet to be completed by AEMO:

- Reviewing the GPS for Mt Mercer to determine if operation at zero MVAr output at low MW output can be allowed. To be completed by 31 December 2016.
- Reviewing internal procedures relating to voltage control at Mt Mercer in particular and all wind farms in general. To be completed by 31 December 2016.

APPENDIX A. – POWER SYSTEM DIAGRAM

The diagram below provides an overview of the relevant part of the transmission network in Victoria during the incident.



APPENDIX B. CONTINGENCY ANALYSIS VIOLATIONS

The table below shows the list of contingencies that would have resulted in voltage violations at MLTS. That is if the contingency in column 1 had occurred then the voltage at MLTS would reach the values shown in column 4. The maximum allowable voltage at MLTS is 230kV.

Contingency	Violation start	Violation finish	Maximum potential voltage at MLTS (kV)
Ballarat – Moorabool No1 220kV line	1112 hrs	1135 hrs	237
	1135 hrs	1302 hrs	232
	1307 hrs	1355 hrs	231
Mortlake – Heywood –APD No2 500kV line and both APD potlines	1112 hrs	1133 hrs	236
	1135 hrs	1146 hrs	231
	1152 hrs	1231 hrs	231
Tarrone – Heywood –APD No1 500kV line and both APD potlines	1112 hrs	1135 hrs	237
	1140 hrs	1157 hrs	231
	1215 hrs	1227 hrs	232
	1239 hrs	1300 hrs	231
Moorabool 220kV reactor	1112 hrs	1133 hrs	236
	1135 hrs	1157 hrs	231
	1215 hrs	1300 hrs	231
APD No1 potline	1112 hrs	1135 hrs	236
	1215 hrs	1243 hrs	231
APD No2 potline	1112 hrs	1133 hrs	236
	1215 hrs	1221 hrs	231
	1227 hrs	1223 hrs	231
APD W1 Transformer	1112 hrs	1133 hrs	235
APD W5 Transformer	1112 hrs	1133 hrs	235
Murraylink	1112 hrs	1133 hrs	237
	1215 hrs	1221 hrs	231
	1231 hrs	1233 hrs	231