POWER SYSTEM IN VICTORIA NOT IN A SECURE OPERATING STATE ON 29 NOVEMBER 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	0547 hrs on 29 November 2016
Region of incident	Victoria
Affected regions	Victoria
Event type	Power system not secure
Generation Impact	There was no loss of generation as a result of this incident
Customer Load Impact	No customer load was disconnected as a result of this incident
Associated reports	Nil

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.

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1. OVERVIEW

This report relates to a reviewable operating incident[1] that occurred on Tuesday 29 November 2016, where the power system in Victoria was not in a secure operating state for greater than 30 minutes due to a number of planned transmission system outages.

There was no loss of customer load or loss of any generation as a result of this incident.

As this was 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:

- The power system was not in a secure operating state for approximately 4.75 hrs.
- Problems associated with the dynamic stability analysis (DSA) application resulted in delays in returning the power system to a secure operating state.
- The potential for non-secure operation was not identified during the outage planning process.
- AEMO has updated its power system security assessment tools and processes as a result of this incident.

This report is prepared in accordance with clause 4.8.15 of the National Electricity Rules (NER). It is based on information from AEMO's energy and market management systems.

Australian Eastern Standard Time (AEST) is used in this report. Local time in Victoria in November is AEST plus one hour.

2. PRE-EVENT CONDITIONS

On the morning of 29 November there were a number of planned outages in Victoria which commenced between 0500 hrs and 0609 hrs:

- Hazelwood – South Morang No. 2 500 kilovolt (kV) transmission line (outage commenced at 0500 hrs).
- Rowville No. 1 220 kV static VAr compensator (outage commenced at 0509 hrs).
- Rowville – Yallourn No. 5 220 kV transmission line (outage commenced at 0531 hrs).
- Rowville A1 500/220 kV transformer (outage commenced at 0535 hrs).
- Dederang No. 1 330/220 kV transformer (outage commenced at 0609 hrs).

There were also two pre-existing outages:

- Rowville No. 2 220 kV static var compensator (SVC).
- Brunswick – Richmond 220 kV transmission line.

Refer to Appendix A for a diagram of the relevant part of the power system during these outages.

The combination of these outages resulted in a reduction in transmission capability between the Latrobe Valley generation and South Morang, and reduced the Victoria region export limits to New South Wales and South Australia.

[1] See NER clause 4.8.15.
[2] See NER clause 4.8.15(b).

The following constraint sets were invoked to manage these outages:

- V-2RP – outage of two SVCs at either Rowville or South East substation.
- V-BTRT – outage of Brunswick to Richmond 220 kV line.
- V-DDTX1 – outage of Dederang No. 1 transformer.
- V-DBUS_L – outage of Dederang DBUSS line control scheme.[3]
- V-HWSM – outage of Hazelwood – South Morang 500 kV line.
- V-ROTX_R – outage of Rowville 500/220 kV transformer.
- V-ROYP5_R – outage of Rowville – Yallourn No. 5 220 kV line.

3. THE INCIDENT

Between 0547 hrs and 0652 hrs, AEMO's contingency analysis tools indicated 500 kV voltage levels up to 22 kV lower than would be required at Moorabool, Keilor, Sydenham, and Cranbourne if the Hazelwood – South Morang No. 1 500 kV line tripped, indicating the power system was not in a secure operating state.

Between 0704 hrs and 1030 hrs, AEMOs' DSA tools indicated transient stability issues if the Hazelwood – South Morang No. 1 500 kV line tripped, again indicating the power system was not in a secure operating state.

4. POWER SYSTEM SECURITY

AEMO is responsible for power system security in the National Electricity Market (NEM). This means AEMO is required to operate the power system in a secure operating state to the extent practicable and take all reasonable actions to return the power system to a secure state following a contingency event in accordance with the NER.[4]

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

4.1 Outage assessment

For each planned outage and combination of planned outages, AEMO is required to conduct an assessment in accordance with its outage assessment procedure[5] to determine what network configuration, limitations, or other measures are required to maintain power system security. These studies are carried out using a powerflow analysis application to determine any potential thermal loading or steady state voltage related issues. AEMO also carries out studies to determine any likely voltage stability issues.

For the combination of outages planned for 29 November in Victoria, the powerflow and voltage stability assessment did not identify any issues. Although AEMO has a transient stability analysis tool (Dynamic Stability Analysis tool, DSA) that is used in real time power system analysis, this tool was still in the development stages to make it suitable for outage assessment analysis. A transient stability analysis was not conducted during the outage assessment process, due to the unreliability of the assessment tool at the time.

[3] The DBUSS line control scheme is normally in place to manage potential overloading of a Murray – Dederang 330 kV line on the trip of the parallel Murray – Dederang 330 kV line. The scheme is required out of service during outages of the Dederang No. 1 transformer.
[4] Refer to AEMO's functions in section 49 of the National Electricity Law and the power system security principles in clause 4.2.6 of the NER.
[5] SO_OP_3718 Outage Assessment.

4.2 Changes made

As a result of this incident AEMO has made changes to its outage assessment tools and processes to reduce the likelihood of this type of incident happening again.

4.2.1 Powerflow analysis

Since this incident, AEMO has reviewed the powerflow analysis application and has determined that an internal setting associated with how reactive devices (capacitors and reactors) would switch automatically in response to either high or low voltages was not set appropriately. This resulted in potential voltage violations not being reported correctly by the application. The correct settings have been implemented.

4.2.2 Stability analysis

As noted above, the outage assessment process did not include a transient stability analysis, due to unreliability of the DSA tools at the time. Since this incident, AEMO has made a number of changes to the DSA, making it more reliable and improving the outputs to make it easier to interpret the results. Additional training in the use of DSA has also been provided to staff involved in outage assessment. AEMO has also put processes in place to ensure a transient stability analysis is routinely carried out during the assessment process for all outages.

4.2.3 Other

AEMO, in conjunction with AusNet Services, is also developing an outage clash list. This will list transmission equipment in the Victoria region that should not be planned out of service concurrently to reduce the risk of the power system not being in a secure operating state. The initial version of this list is expected to be completed by September 2017.

4.3 Real time operation

From approximately 0547 hrs, AEMO's contingency analysis application was showing low voltage violations if the Hazelwood – South Morang No. 1 500 kV line (HWTS-SMTS 1 line) tripped, as shown in Table 1.

Table 1 Voltage violations

Time	Location	Violation (kV)
29/11/2016 05:47	South Morang Terminal Station (SMTS)	-3
29/11/2016 05:47	Keilor Terminal Station (KTS)	-3
29/11/2016 05:47	Sydenham Terminal Station (SYTS)	-2
29/11/2016 05:53	SMTS	-2
29/11/2016 05:53	KTS	-1
29/11/2016 05:59	SMTS	-2
29/11/2016 05:59	KTS	-2
29/11/2016 05:59	SYTS	-1
29/11/2016 06:33	SMTS	-9
29/11/2016 06:33	KTS	-9
29/11/2016 06:33	SYTS	-8
29/11/2016 06:33	SYTS	-6
29/11/2016 06:33	Moorabool Terminal Station (MLTS)	-22
29/11/2016 06:33	Cranbourne Terminal Station (CBTS)	-2
29/11/2016 06:33	Brooklyn Terminal Station (BLTS)	-1
29/11/2016 06:33	Rowville Terminal Station (ROTS)	-1

AEMO implemented a number of voltage control actions, and the majority of voltage violations were cleared by 0633 hrs. These actions were hampered by the fact large reactive plant could not be placed in service, because it would create high voltage violations on the power system due to the lack of dynamic reactive capability given the outage of both SVCs at ROTS and the recent de-commissioning of synchronous compensators at Fisherman's Bend, Brooklyn, and Templestowe.

From 0704 hrs, DSA started to indicate possible transient stability issues for the loss of the HWTS-SMTS 1 line. AEMO did not take action at this time, on the basis that the DSA application was producing inconsistent and potentially incorrect results, and the voltage situation was improving and demand was reducing as a result of the switching off of hot water systems.

After further investigation, AEMO's congestion modelling team determined that DSA results were correct and the power system was not in a secure operating state.

From 0905 hrs, AEMO applied a number of constraint sets (DSA offset constraints) to reduce the Victoria region export limits by increasing amounts, as shown in Table 2. At 1025 hrs, AEMO developed and invoked a multiple outage constraint set V-X_HWSM_ROTX_R to replace the DSA offset constraints. DSA violations ceased and the power system returned to a secure operating state when this constraint set was invoked.

Table 2 Constraints invoked to manage DSA violations

Constraint set	Invoke time	Revoke time	Description
V-DSA_STAB_100	0905 hrs	0920 hrs	Reduce VIC transient stability export limits by 100 megawatts (MW)
V-DSA_STAB_200	0920 hrs	0930 hrs	Reduce VIC transient stability export limits by 200 MW
V-DSA_STAB_300	0930 hrs	0935 hrs	Reduce VIC transient stability export limits by 300 MW
V-DSA_STAB_350	0935 hrs	0945 hrs	Reduce VIC transient stability export limits by 350 MW
V-DSA_STAB_400	0945 hrs	1030 hrs	Reduce VIC transient stability export limits by 400 MW
V-X_HWSM_ROTX_R	1025 hrs	1510 hrs	Out = HWTS-SMTS line and Rowville A1 transformer

As noted in Section 4.1, since this event AEMO has made a number of changes to the DSA application to improve its reliability and accuracy.

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[6] over the course of this incident.

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

- Inter-regional transfer limit variation – AEMO issued market notices 55879, 55880, 55881, and 55883 between 0903 hrs and 1054 hrs on 29 November 2016 to advise the market of changes to the Victoria region export limits.

No other market notices were required.

Over the course of this incident, AEMO issued appropriate, timely, and sufficiently detailed market information.

6. CONCLUSIONS

AEMO has assessed this incident in accordance with clause 4.8.15 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:

- The power system was not in a secure operating state for approximately 4.75 hrs.
- Problems associated with the DSA application resulted in delays in returning the power system to a secure operating state.
- The potential for non-secure operation was not identified during the outage planning process, due to the unreliability of DSA at the time.
- AEMO has updated its power system security assessment tools and processes as a result of this incident.

[6] AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see https://www.aemo.com.au/Market-Notices.

7. PENDING ACTIONS

AEMO in conjunction with AusNet to develop an outage clash list for the Victoria region by 30 September 2017.

APPENDIX A. POWER SYSTEM DIAGRAM