TRIP OF SOUTH EAST SUBSTATION No 1 AND No 2 275 KV SVCs ON 23 APRIL 2016

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

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	2006 hrs Saturday 23 April 2016
Region of incident	South Australia
Affected regions	South Australia
Event type	Loss of multiple transmission elements
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
SVC	Static Var Compensator

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 Saturday 23 April 2016, and subsequent related events that occurred on Friday 29 April 2016 involving the simultaneous trip of No. 1 and No. 2 Static Var Compensators (SVCs) at South East substation (SESS) in South Australia.

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 trip of the SVCs resulted from the failure of the 415V auxiliary supply to the SVCs.
2. AEMO correctly applied the reclassification procedures to reclassify the simultaneous loss of both SVCs as a credible contingency event.
3. During the reclassification, a constraint set was invoked when it should not have been.
4. The power system was in a secure operating state.

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 Electranet[3] and AEMO.

National Electricity Market time (Australian Eastern Standard Time) is used in this report.

2. THE INCIDENT

While this report focuses on the event where both SVCs at SESS tripped simultaneously, a number of related events on 23 April and 29 April 2016 resulted in tripping of either one or both SVCs.

Event 1

- At 0925hrs on 23 April, during planned switching to isolate the 132kV west bus at SESS the No.1 SVC tripped. The SVC was returned to service at 1038 hrs on 23 April.

Event 2

- At 2006 hrs on 23 April during switching to return the 132kV west bus to service, the SESS No.1 and No.2 SVCs tripped simultaneously. Both SVCs were returned to service at 2045 hrs on 23 April.

In response to this event, AEMO reclassified the simultaneous loss of both SVCs as a credible contingency event. Refer to section 4.1 for details.

Event 3

- On 29 April during a planned outage of the SESS No.2 SVC for testing and rectification works associated with the event on 23 April, the SESS No.1 SVC tripped at 0933 hrs and was returned to service at 0947 hrs on 29 April.

Event 4

- On 29 April during a planned outage of the SESS No.1 SVC for testing and retification works associated with the event on 23 April, the SESS No.2 SVC tripped at 1036 hrs and was returned to service at 1102 hrs on 29 April.

[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] Electranet is the Transmission Network Service Provider in South Australia

No load or generation was lost as a result of these incidents.

See Appendix A for a chronological log of the incidents.

The reason for investigating these incidents is that, on one occasion, two elements of transmission equipment tripped at the same time. Generally the probability of two elements of transmission equipment tripping at the same time is very low and is thereby an unexpected event known in power system security terms as a non-credible contingency[4].

3. ELECTRANET INVESTIGATION

Electranet, the Transmission Network Service Provider (TNSP) for South Australia, provided the following information.

The trip of the SVCs on each occasion was due to a failure of auxiliary power supplies to the SVCs' cooling systems during routine switching and subsequent testing.

The SVC's cooling system relies on a 415V power supply. This 415V supply is provided via either a main, standby or emergency diesel 415V power supply. If the main supply is unavailable, an automatic changeover occurs to the standby supply. If the main and standby supply are unavailable, a separate automatic changeover occurs to the emergency diesel supply. A diagram and a more detailed description of the incidents are provided in Appendix B.

The loss of auxiliary power supply on 23 April was due to a combination of:

- Planned switching, which isolated the main supply.
- A faulty standby supply changeover switch.
- Failure of the emergency diesel supply.

The faulty standby changeover switch contributing to this trip was subsequently replaced, tested and confirmed to be operating correctly.

The loss of auxiliary power supply on 29 April was due to a combination of:

- Planned switching, which isolated the main and standby supply.
- Failure of the emergency diesel supply.

The faulty emergency diesel changeover is due to be replaced by December 2016.

Pending the final rectification work, Electranet has assessed the 415V auxiliary supply network and has determined the risk of tripping both SVCs simultaneously due to any single fault in the 415 V auxiliary supply system is low.

4. 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 how power system security over the course of this incident[5].

[4] NER Clause 4.2.3 - Credible and non-credible contingency events; *AEMO Power System Security Guidelines,* Section 10 - Definition of a non-credible contingency events

[5] 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.

Event 1

- AEMO invoked constraint set S-SE_VC_1[6] at 0940 hrs, 15 minutes after the SVC tripped.
    - Constraint set S-SE_VC_1 was revoked at 1050 hrs after the SVC was returned to service.

Event 2

- AEMO invoked constraint set S-X_SESS_SVC-BOTH[7] at 2015 hrs, nine minutes after the trip of both SVCs.
    - Constraint set S-X_SESS_SVC-BOTH was revoked at 2100 hrs on 23 April following the return to service of both SVCs.

Event 3

- AEMO invoked constraint set S-X_SESS_SVC-BOTH at 0945 hrs, twelve minutes after the trip of No 1 SVC at 1036hrs on 29 April.
    - Constraint set S-X_SESS_SVC-BOTH was revoked at 0955 hrs on 29 April following the return to service of both SVCs.

Event 4

- AEMO invoked constraint set S-X_SESS_SVC-BOTH at 1040 hrs, four minutes after the trip of No 1 SVC at 1036 hrs on 29 April.
    - Constraint set S-X_SESS_SVC-BOTH was revoked at 1110 hrs on 29 April following the return to service of both SVCs

These actions ensured that the power system was in a secure operating state with the SVCs out of service. AEMO is required to return the power system to a secure state within 30 minutes following a contingency event.[8]

4.1 Reclassification

After the SVCs were returned to service on 23 April, AEMO assessed whether or not to reclassify the simultaneous loss of both SVCs as a credible contingency event[9]. For this incident, AEMO was not satisfied that the cause had been identified or that the incident was unlikely to reoccur. AEMO reclassified the simultaneous loss of both SVCs as a credible contingency event at 2129 hrs on 23 April.

Initially no constraint set was invoked for this reclassification. However a review of AEMO's constraint library on 25 April identified there was a constraint set (S-SE_SVC_N-2[10]) applicable for when the loss of both SVCs was declared credible. This constraint set was invoked at 2130 hrs on 25 April. A review of this constraint set on 26 April determined the constraint set was no longer applicable due to recent changes in the transmission network in South Australia. The constraint set was revoked at 0855 hrs on 26 April. No further constraint sets were required to manage power system security during the reclassification period. While the constraint set was invoked, no constraint equations from this constraint set bound, that is, the constraint set had no impact on market outcomes.

Following this event AEMO has reviewed the constraint library and has removed outdated constraint sets.

[6] Voltage and transient stability limits with a single SVC at SESS out of service
[7] Voltage and transient stability limits with both SVCs at SESS out of service
[8] AEMO is required to return the power system to a secure state within thirty minutes following a contingency event - NER Clause 4.2.6 (b)
[9] AEMO is required to assess whether or not to reclassify a non credible contingency event as a credible contingency - NER Clause 4.2.3A (c) - and to report how re-classification criteria were applied - NER Clause 4.8.15 (ca). AEMO has to determine if the condition that caused the non-credible contingency event has been resolved.
[10] Voltage and transient stability limits when loss of both SVCs declared a credible contingency event.

Based on advice from Electranet that the simultaneous trip of both SVCs due to a single fault is no longer likely, AEMO cancelled the reclassification on 23 June 2016.

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[11] over the course of this incident.

In relation to the simultaneous trip of both SVCs on 23 April, AEMO was required to inform the market on the following matters:

1. A non-credible contingency event - notify within two hours of the event.[12]

   AEMO issued Market Notice 52857 at 2031 hrs – 25 minutes after the event.

2. Constraints invoked with interconnector terms on the LHS.[13]

   AEMO issued Market Notice 52857 at 2031 hrs – 25 minutes after the event.

   AEMO issued Market Notice 52865 at 2133 hrs on 25 April to advise the market that a constraint set associated with the reclassification had been invoked.

3. A reclassification or cancellation of reclassification of contingency events - notify as soon as practical.[14]

   AEMO issued Market Notice 52858 at 2129 hrs on 23 April advising of the reclassification – 44 minutes after the SVCs were returned to service.

   AEMO issued Market Notice 54078 at 0927 hrs on 23 June advising of the cancellation of the reclassification.

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

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 concluded that:

1. The trip of either one of both SVCs on 23 April and 29 April was due to faults within the 415V auxiliary supplies for the SVCs.
   - A faulty standby supply changeover switch has been replaced and proven to be working correctly.
   - The fault with the emergency diesel supply is to be rectified by December 2016
2. AEMO correctly applied the reclassification procedures to reclassify the simultaneous loss of both SVCs as a credible contingency event.

[11] AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see AEMO website
[12] AEMO is required to notify the Market of a non-credible contingency event within two hours of the event - AEMO, *Power System Security Guidelines,* Section 10.3
[13] For short term outage AEMO is required to notify the Market of variances to interconnector transfer limits AEMO, *Power System Security Guidelines,* Section 22
[14] AEMO is required to notify the market of a reclassification NER clause 4.2.3(g), details of the reclassification 4.2.3(c) and when AEMO cancels the reclassification 4.2.3(h)

3. During the reclassification, a constraint set was invoked when it should not have been.
4. The power system was maintained in a secure operating state.

7. PENDING ACTIONS

Electranet will advise AEMO when the rectification works are completed.

APPENDIX A. – INCIDENT EVENT LOG

Chronological Log of Incident

Table 1 Incident Chronology – 23 April 2016

Time and Date	Event
0925 hrs 23 April 2016	SESS No.1 SVC tripped during planned switching to isolate the 132kV west bus.
0940 hrs	Constraint set S-SE_VC_1 invoked
1038 hrs	SESS no.1 SVC returned to service
1050 hrs	Constraint set S-SE_VC_1 revoked
2006 hrs	SESS No 1 & 2 275 kV SVCs tripped simultaneously during switching to restore the 132kV west bus.
2015 hrs	Constraint Set S-X_SESS_SVC-BOTH invoked
2031 hrs	Market Notice 52857 issued advising of non-credible contingency
2045 hrs	SESS No 1 & 2 275 kV SVCs returned to service
2100 hrs	Constraint Set S-X_SESS_SVC-BOTH revoked
2129 hrs	Market Notice 52857 issued advising of reclassification
2133 hrs Mon 25 Apr 2016	Constraint set S-SE_SVC_N-2 invoked and Market Notice 52865 issued.
0855 hrs Tue 26 Apr 2016	Constraint set S-SE_SVC_N-2 revoked
0918 hrs	Market Notice 52865 issued advising of constraint set revoked

Table 2 Incident Chronology – 29 April 2016

Time and Date	Event
0933 hrs Sat 23 Apr 2016	South East substation No 1 275 kV SVC tripped during planned outage of No.2 SVC
	Constraint Set S-X_SESS_SVC-BOTH invoked
0947 hrs	SESS No.1 SVC returned to service
	Constraint Set S-X_SESS_SVC-BOTH revoked
1036 hrs	South East substation No 2 275 kV SVC tripped during planned outage of No.1 SVC
1040 hrs	Constraint Set S-X_SESS_SVC-BOTH invoked
1102 hrs	SESS No 2 275 kV SVC returned to service
1107 hrs	Market Notice 52857 issued advising of inter-regional transfer limit variation
1110 hrs	Constraint Set S-X_SESS_SVC-BOTH revoked

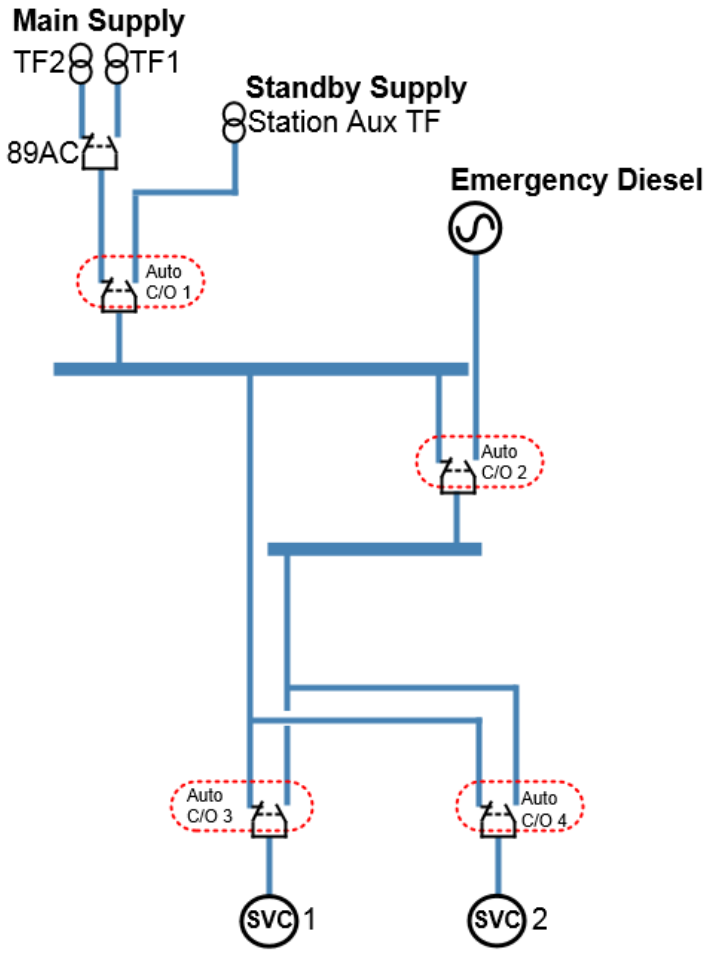
APPENDIX B. – SVC 415V AUXILIARY SUPPLIES

South East substation SVC 1 and SVC 2 require a 415V supply to maintain water cooling to the thyristor valves. If the 415V supply to the cooling system pumps is interrupted for greater than seven seconds, the SVCs are tripped.

The 415V supply to each SVC is provided via a number of changeover switches as shown in Figure 1. A main supply is derived from either TF1 or TF2 auxiliary transformers, via switch 89AC. If this main supply fails an auto changeover, C/O 1, operates to switch the 415V source to the site Station Transformer supply. If normal and standby supplies fail a standby generator is started automatically and this will maintain essential 415V supplies to site, via changeover C/O 2.

Each SVC has a main and standby 415V supply and an automatic changeover switch. If the main 415V supply fails the SVCs should automatically switch to their standby supply via C/O 3 and C/O 4.

Figure 1 South East Substation 415V Supply



Event 1

During switching to isolate the 132kV west bus, TF2 was required to be isolated and this required the transfer of the 415V supply from TF2 to TF1 via switch 89AC. This is a three position switch, TF2-OFF-TF1, and controls the normal supply to the 415V supply boards.

Before operating this switch the site operator and the TSO in the SMSC discussed an active 415V Supply Failure alarm. This active alarm indicated that the standby 415V supply had failed. Both the site operator and TSO concluded that switching could continue, and switch 89AC should operate quickly to restore supplies after a short break in supply.

During operation of 89AC switch through the OFF position, the site 415V supply did not transfer to the standby supply or to the diesel supply and 415V supplies to SVC 1 were momentarily interrupted for greater than seven seconds. This led to a Cooling System Failure and tripping of SVC 1. SVC 2 did not trip due to slight discrepancies in the supply fail timers.

Event 2

After the 132kV west bus and TF2 were restored to service, the switching operator attempted to restore switch 89AC to the TF2 position. However switch 89AC failed and remained stuck in the OFF position. Again the 415V supply did not transfer to the standby supply or the diesel supply, resulting in a loss of 415V supply and the trip of both SVCs.

A faulty changeover switch (C/O1) was replaced on 26 April.

Event 3

Further testing on the 415V supply was undertaken. SVC 2 was taken out of service to prevent both SVCs unexpectedly tripping during testing. During testing on SVC 1, changeover switch C/O 3 failed to operate resulting in a loss of 415V supply to SVC 1. The faulty changeover switch (C/O3) was repaired/replaced. Changeover switch C/O4 was proved to be working correctly. Both SVCs were returned to service on completion of testing.

Event 4

A final test was required to test the changeover to the diesel supply. SVC1 was taken out of service prior to this test. Both main and standby supplies were isolated but while the diesel successfully started the diesel supply changeover switch (C/O2) failed to operate resulting in the loss of 415V supplies to both SVCs.