Power System Operating Incident Report – Trip of Upper Tumut 5A1 and 5B 330 kV Busbars on 11 December 2013

PREPARED BY: Systems Capability

DATE: 6 March 2014

STATUS: FINAL

Contents

1 Introduction 4

2 The Incident 4

3 TNSP Investigation 4

4 Power System Diagrams 5

5 Incident Event Log 6

6 Immediate Actions 6

7 Follow-up Actions 7

8 Power System Security 8

9 Conclusions 8

10 Recommendations 8

Disclaimer

Purpose

This report has been prepared by the Australian Energy Market Operator Limited (AEMO) for the sole purpose of meeting obligations in accordance with clause 4.8.15 (c) of the National Electricity Rules (NER).

No reliance or warranty

This report contains data provided by third parties and might contain conclusions or forecasts and the like that rely on that data. This data might not be free from errors or omissions. While AEMO has used due care and skill, AEMO does not warrant or represent that the data, conclusions, forecasts or other information in this report are accurate, reliable, complete or current or that they are suitable for particular purposes. You should verify and check the accuracy, completeness, reliability and suitability of this report for any use to which you intend to put it, and seek independent expert advice before using it, or any information contained in it.

Limitation of liability

To the extent permitted by law, AEMO and its advisers, consultants and other contributors to this report (or their respective associated companies, businesses, partners, directors, officers or employees) shall not be liable for any errors, omissions, defects or misrepresentations in the information contained in this report, or for any loss or damage suffered by persons who use or rely on such information (including by reason of negligence, negligent misstatement or otherwise). If any law prohibits the exclusion of such liability, AEMO's liability is limited, at AEMO's option, to the re-supply of the information, provided that this limitation is permitted by law and is fair and reasonable.

© 2014 Australian Energy Market Operator Ltd. All rights reserved

Version Release History

VERSION	DATE	BY	CHANGES	CHECKED BY	AUTHORISED BY
1	6 Mar 2014	S Darnell	FINAL	P Biddle	P Biddle

Incident Classifications

Time and date and of incident	0742 hrs Wednesday 11 December 2013
Region of incident	New South Wales
Affected regions	New South Wales
Event type	BB – Busbar trip
Primary cause	PROC – Procedural Issues
Impact	140 MW of Generation disconnected
Associated reports	Nil

Abbreviations and Symbols

Abbreviation	Term
AEMO	Australian Energy Market Operator
CB	Circuit Breaker
CT	Current Transformer
EMMS	Electricity Market Management System
EMS	Energy Management System
kV	Kilovolt
MW	Megawatt
NER	National Electricity Rules
TransGrid	Transmission Network Service Provider in the New South Wales Region
TNSP	Transmission Network Service Provider

1 Introduction

This report reviews a power system operating incident that occurred on 11 December 2013 in the New South Wales region at Upper Tumut switching station. AEMO is required to review this incident as it is classified as a non-credible contingency that satisfies the requirements of a reviewable operating incident under the National Electricity Rules[1] (NER).

The purpose of this incident review is to assess power system security over the course of the incident. The NER requires AEMO 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[2].

This report is based upon information provided by TransGrid[3]. Data from AEMO's Energy Management System (EMS) and Electricity Market Management System (EMMS) has also been used in analysing the incident.

References to time in this report are to National Electricity Market time (Australian Eastern Standard Time).

2 The Incident

On Wednesday 11 December 2013 at 0742 hrs, the 5A1 and 5B 330 kV Busbars at Upper Tumut Switching Station tripped. This resulted in the off-loading of the Upper Tumut - Canberra (01) 330kV transmission line (Canberra line) and the loss of approximately 140 MW of generation at Upper Tumut Power Station. No load was lost as a result of this incident.

The reason for investigating this incident is that a transmission busbar tripped – in this case two busbars. The probability of a busbar fault is very low and is therefore an unexpected event known in power system security terms as a non-credible contingency.

3 TNSP Investigation

TransGrid investigated this incident and found that a switching error caused the trip of 5A1 and 5B 330 kV busbars at Upper Tumut Switching Station. The switching error occurred whilst TransGrid were switching circuits from 5A1 busbar to 5B busbar. Busbar 5A1 was being taken out of service for a planned outage. Normally all circuits are connected to the 5A1 and 5A2 busbars. Busbar 5B is normally de-energised.

At the time of the incident, the Canberra line was paralleled between busbars 5A1 and 5B. The busbars tripped as 330 kV Isolator 015 was opened to transfer the Canberra line to the 5B busbar.

The busbars tripped because the busbar protection secondary circuits (CTs) were incorrectly configured. When 5A1 busbar is connected to busbar 5B, the bus coupler CT (5012) needs to be connected to the CT summation for busbars 5A1 and 5B. A manual selector switch connects the bus-coupler CT to either 5A1 busbar or to 5A2 busbar. For this incident the selector switch had been incorrectly set to the 5A2 busbar.

The secondary current for both the 5A2 busbar and the combined 5A1 and 5B busbar protection circuits was thereby not balanced. The 5A1 and 5B busbar protection was more sensitive to the unbalance so the 5A1 and 5B protection operated first[4]. Following the trip of 5A1 and 5B busbars, the current flow through the bus coupler ceased so 5A2 busbar protection did not subsequently operate.

The operation of 5A1 and 5B busbar protection, in turn, opened 330 kV circuit breakers 5012, 5102, U72, O12 and U12 at Upper Tumut switching station. As a consequence Upper Tumut generating units 1 and 7 were disconnected, and the Canberra line was off-loaded.

[1] NER v60 Clause 4.8.15(a)(1)(i) and AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

[2] NER v60 Clause 4.8.15 (b).

[3] TransGrid is Transmission Network Service Provider in New South Wales.

[4] The difference in sensitivity is because the two protection zones have a different number of CTs and therefore unequal excitation currents

The root cause of this incident was that switching operators did not correctly observe the TransGrid switching procedure for transferring circuits from busbar 5A1 to 5B.

4 Power System Diagrams

The status of the power system at Upper Tumut switching station before and after the incident is shown in Figures 1 and 2 respectively. Figure 1 shows the Canberra line was paralleled between 5A1 and 5B busbars. Figure 2 shows 5A1 and 5B busbars de-energised via open circuit breakers and generating unit circuit breakers V100 and V700 open.

Figure 1 - Status of the power system prior to the incident

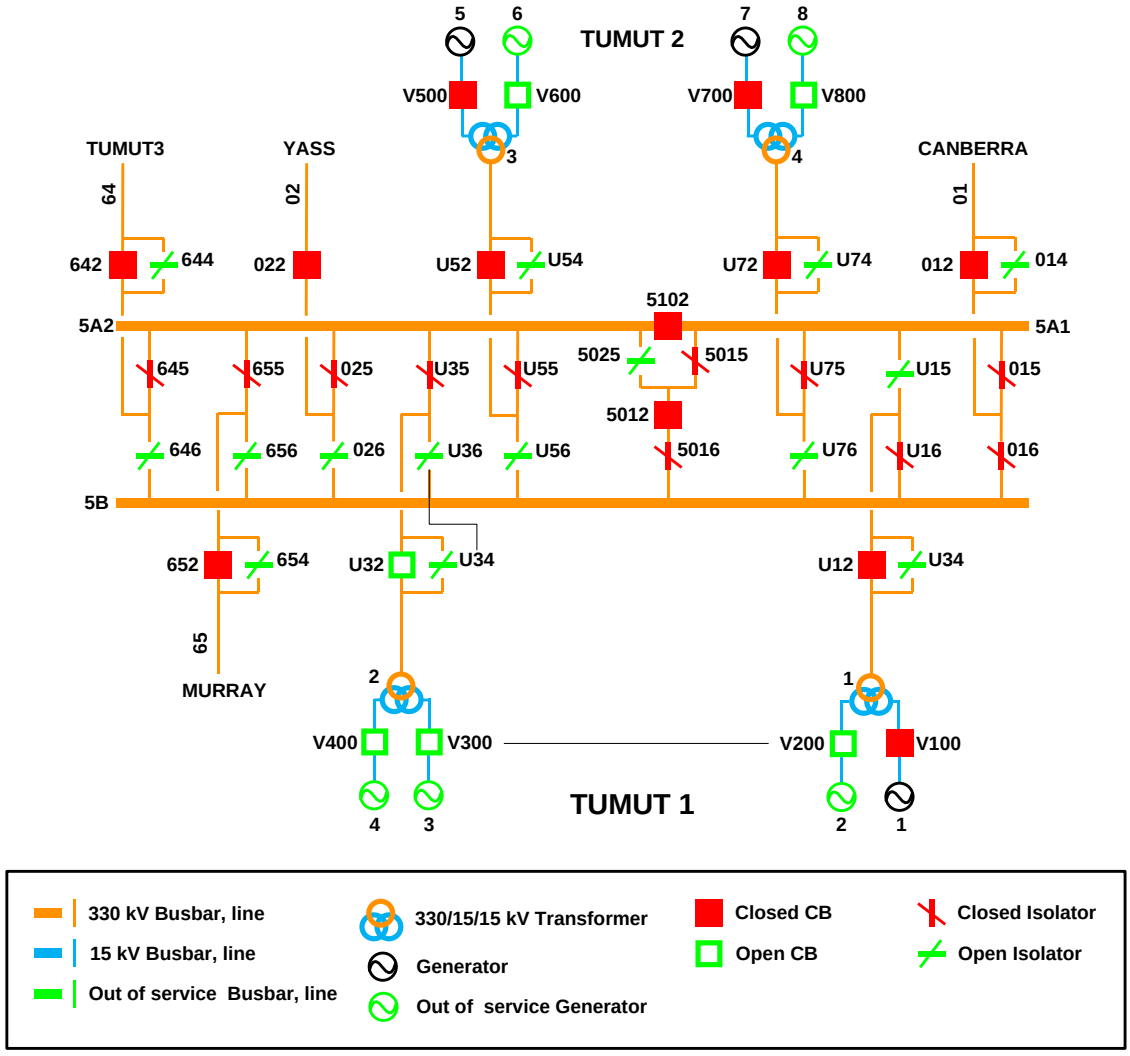
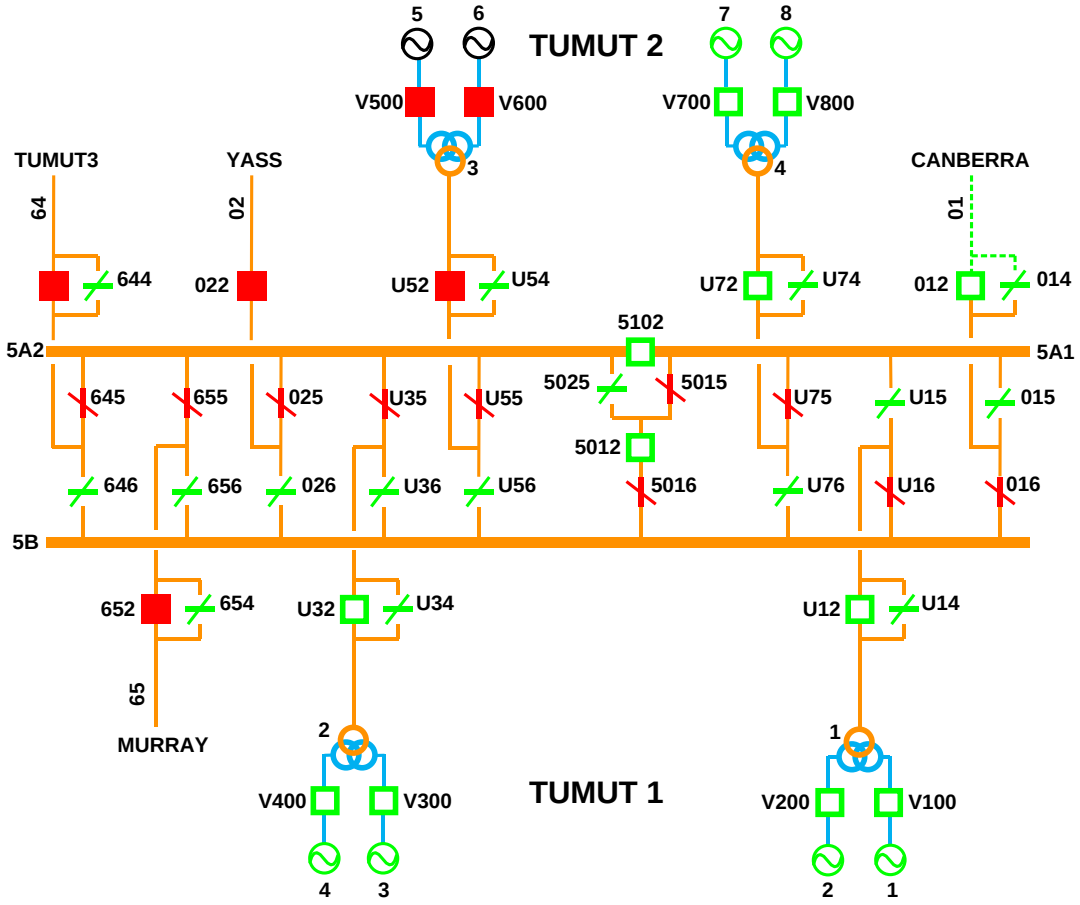


Figure 2 - Status of the power system immediately after the incident



5 Incident Event Log

The sequence of events comprising the incident are itemised in Table 1. The incident spanned approximately 3 hours from the busbar trips to busbar re-energisation.

6 Immediate Actions

This section assesses the immediate actions taken in response to the incident.

At 0750 hrs AEMO invoked constraint set N-CNUT_01[5]. This action ensured that the power system was in a secure operating state.[6]

At 0805 hrs, AEMO issued Market Notice 44178 to notify the market that:

- The Upper Tumut - Canberra 01 330kV transmission line was out-of-service
- Constraint set N-CNUT_01 was invoked at 0750 hrs.
- The constraint set N-CNUT_01 contained equations with interconnectors on the LHS.

[5] Constraint Set N-CUT_01 is invoked for the outage of the Canberra – Upper Tumut 330 kV transmission line. The six constraint equations in the set limit flows on nearby lines so that they do not overload in the event of a nearby line off-loading.

[6] AEMO is required to return the power system to a secure state within thirty minutes following a contingency event - NER v60 Clause 4.2.6 (b).

At 0833 hrs 11 December 2013 AEMO then issued Market Notice 44179 to notify the market of:

- The non-credible contingency event.[7]
- The de-energisation of the 5A1 and 5B 330 kV busbars at Upper Tumut Switching Station.
- The offloading of the Canberra line and of approximately 140 MW of generation.

The immediate actions taken by AEMO were appropriate for this incident.

Table 1 – Event Log

Date and Time	Event
0712 hrs 11 Dec 2013	AEMO grant TransGrid permission to begin switching at Upper Tumut Switching Station
0723 hrs 11 Dec 2013	330 kV Isolator 5015 closed
0725 hrs 11 Dec 2013	330 kV Circuit Breaker 5012 closed (bus-coupler)
0738 hrs 11 Dec 2013	330 kV Isolator U16 closed
0740 hrs 11 Dec 2013	330 kV Isolator U15 opened
0741 hrs 11 Dec 2013	330 kV Isolator O16 closed
0742 hrs 11 Dec 2013	330 kV Isolator O15 opened Circuit breakers O12, U72, U12, 5102 and 5012 opened - 5A2 and 5B busbars de-energised
0750 hrs 11 Dec 2013	Constraint set N-CNUT_01 invoked
0805 hrs 11 Dec 2013	Market Notice 44178 issued to notify the market that: • Upper Tumut - Canberra (01) 330kV transmission line off-loaded. • Constraint set N-CNUT_01 invoked at 0750 hrs
0833 hrs 11 Dec 2013	Market Notice 44179 to notify the market of the non-credible contingency events
1036 hrs 11 Dec 2013	Circuit breakers 5102 and O12 closed - 5A1 330 kV busbar returned to service
1224 hrs 11 Dec 2013	Market Notice 44181 issued to notify the market: • The event was not re-classified as a credible contingency • AEMO was satisfied that another occurrence of the event was unlikely

7 Follow-up Actions

This section assesses follow-up actions taken to resolve the incident.

At 1036 hrs TransGrid closed circuit breaker 5102 to re-energise 5A1 busbar and then returned the Canberra line to service.

At 1130 hrs AEMO issued Market Notice 44180 to notify the market that constraint set N-CNUT_01 had been revoked.

At 1224 hrs AEMO issued Market Notice 44181 to notify the market that the event was not to be re-classified as a credible contingency[8]. AEMO was satisfied TransGrid had identified the cause of the incident and that the incident was unlikely to reoccur.

The follow-up actions taken by AEMO and TransGrid were appropriate for this incident.

[7] AEMO is required to notify the market of a non-credible contingency event within two hours of the event - AEMO, *Power System Security Guidelines,* v54 Section 10.3

[8] AEMO is required to assess whether or not to reclassify a non credible contingency event as a credible contingency (NER v60 Clause 4.2.3A (c)) and to report how re-classification criteria were applied (NER v60 Clause 4.2.3A (c)). AEMO has to determine if the condition that caused the non-credible contingency event has been resolved

8 Power System Security

This section assesses how power system security was managed over the course of the incident[9].

For this incident AEMO invoked the appropriate constraint set to ensure the power system was returned to a secure state, issued the required market notices in a timely manner, and correctly assessed the incident as non-credible contingency.

These actions ensured Power System security was maintained over the course of the incident.

9 Conclusions

1. The 5A1 and 5B busbars at Upper Tumut Substation tripped because the busbar protection secondary circuits were incorrectly configured.
2. Switching operators did not correctly observe the TransGrid switching procedure for transferring circuits from busbar 5A1 to 5B
3. Over the course of the incident, the response of AEMO and TransGrid was appropriate and power system security was maintained.

10 Recommendations

There are no recommendations arising from this review.

[9] AEMO is responsible for power system security in the NEM and is required to operate the power system in a secure operating state (NER v60 Clause 4.2.6 (a) and 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. In the case of returning the power system to a secure operating state this must be done as soon as practical and in any event within thirty minutes (NER v60 Clause 4.2.6 (b))