POWER SYSTEM OPERATING INCIDENT REPORT – TRIPS OF YALLOURN W POWER STATION UNITS W1 AND W3 ON 14 NOVEMBER 2012

PREPARED BY: System Performance and Commercial

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FINAL

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Abbreviations and Symbols

Abbreviation	Term
Auxiliary Transformer 'A'	220/6.6 kV Auxiliary Transformer 'A' at YWPS
CB	Circuit Breaker
CT	Current Transformer
DCS	Distributed Control System
EMMS	Electricity Market Management System
EMS	Energy Management System
FCAS	Frequency Control Ancillary Service
HWPS	Hazelwood Power Station
kV	Kilovolt
NEM	National Electricity Market
MW	Megawatt
Relay Logic	The electrical protection trip series relays equipment at YWPS
ROTS	Rowville Terminal Station
TOC	Transmission Operations Control (SP AusNet)
Unit W1	Yallourn W Power Station (YWPS) units W1
Unit W3	Yallourn W Power Station (YWPS) units W3
YPS	Yallourn Power Station. In the context of this report, this reference relates to the 220 kV Switchyard.
YWPS	Yallourn W Power Station

Contents

Incident summary

Date and time of incident	14 November 2013 at 0717 hours
Region of incident	Victoria
Affected regions	Victoria
Event type	GG – Loss of multiple generating units
Primary cause	PTN & CTR – Protection and Control
Impact	Very Significant
Associated reports	N/A

1 Introduction

At 0715 hours on 14 November 2012, Yallourn W Power Station (YWPS) units W1 ('**unit W1**' and W3 ('**unit W3**') tripped after interruption to supplies to their auxiliary equipment. This occurred following the de-energisation of the 220/6.6 kV Auxiliary Transformer 'A' at YWPS ('**Auxiliary Transformer 'A'**') after the opening of the 220 kV CB YPS/31 at YPS. This incident resulted in a total reduction of generation of approximately 753 MW, all at YWPS. Unit W3 returned to service at 2014 hours on 14 November 2012, and unit W1 returned to service at 1210 hours on 15 November 2012. YWPS unit W2 was previously out-of-service during a planned outage. YWPS unit W4 remained in service through the incident. As a result of the loss of multiple generating units, the Mainland region power system frequency in National Electricity Market (NEM) dropped to a minimum of 49.75 Hz and remained within the relevant Frequency Operating Standard for the NEM mainland regions. There was no loss or interruption of load due to this incident.

This report has been prepared under clause 4.8.15 (c) of the National Electricity Rules (NER) 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.

This report is largely based upon information provided by Energy Australia and SP AusNet[1]. Data from AEMO's Energy Management System (EMS) and Electricity Market Management System (EMMS) has also been used in analysing the incident.

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

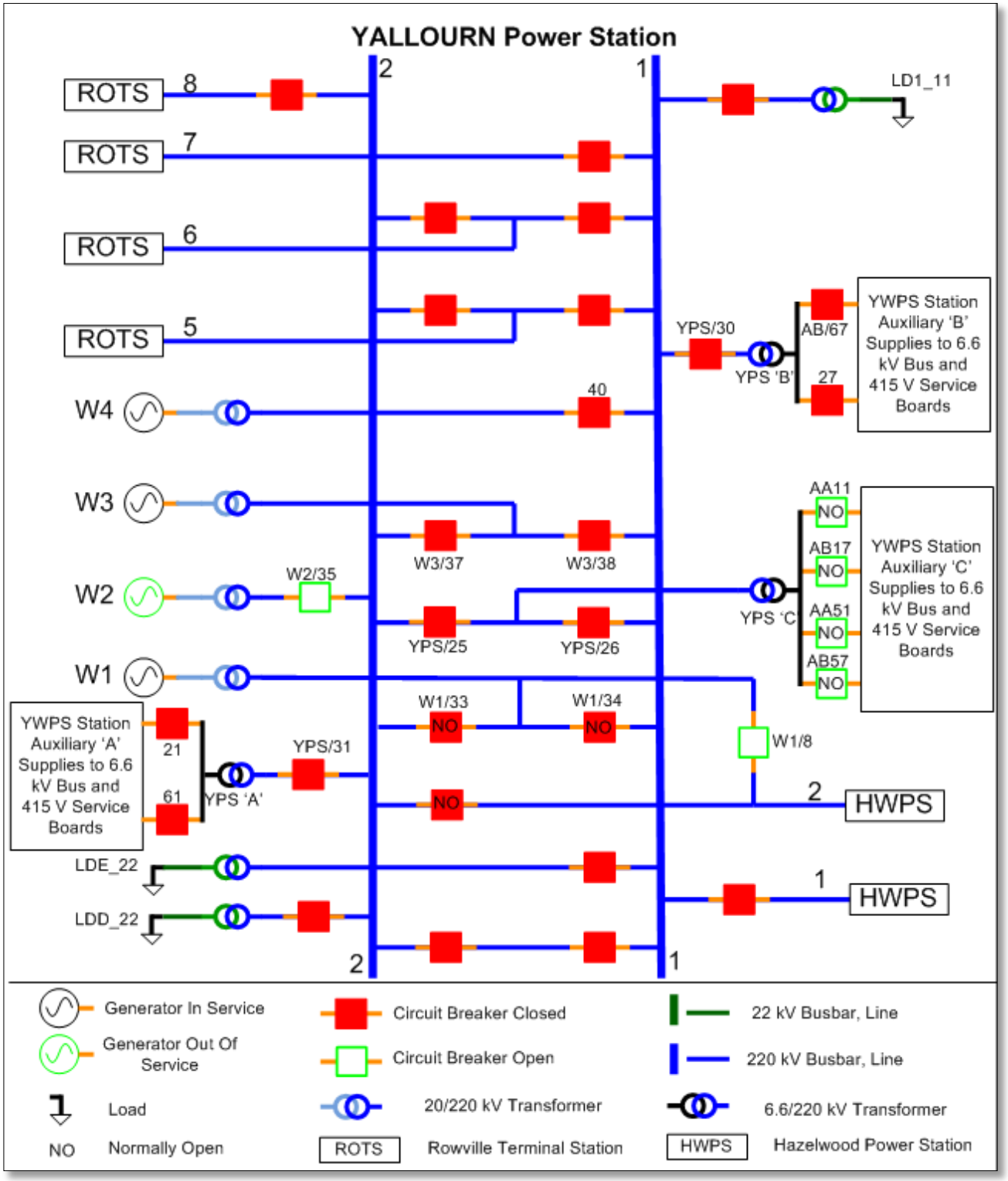
2 Pre-Contingent System Conditions

Prior to the incident, all equipment connected to the No. 1 and No. 2 220 kV Busbars at YPS was in service. YWPS unit W2 was offline as a result of planned outage and the other three YWPS units were in service generating a total output of approximately 950 MW.

The status of the power system prior to the incident is shown in Figure 1. For clarity only equipment relevant to this incident has been included in the diagram.

[1] Information provided by SP AusNet has been provided on a without prejudice basis and nothing in this report is intended to constitute, or may be taken by any person as constituting, an admission of fault, liability, wrongdoing, negligence, bad faith or the like on behalf of SP AusNet (or its respective associated companies, businesses, partners, directors, officers or employees).

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



3 Summary of Events

The key events that took place during the incident are summarised in Table 1 below. Auxiliary Transformer 'A' at YWPS was de-energised when the 220 kV CB YPS/31 at YPS (YPS switchyard end) opened due to a reason that was not identified at the time. The Auxiliary Transformer 'A' 6.6 kV CB 21 and CB 61 (YWPS station and unit board side) remained closed. This resulted in the interruption of auxiliary supplies to several station auxiliary boards and unit boards, however the

Relay Logic at YWPS did not initiate an automatic changeover to an alternate supply from the 220/6.6 kV Auxiliary Transformer 'C' at YWPS.

Unit W1 and unit W3 tripped at 0717 hrs and 0723 hrs respectively, following the interruption of supplies to their auxiliary equipment.

Automated generating unit protection tripping of units W1 and W3 under the conditions of this incident would typically occur upon detection of reverse power. However it did not occur on this occasion due to the faulty Reverse Power Relays on each unit. These Reverse Power Relays "locked up" due to internal electronic faults. After the incident, the faulty Reverse Power Relays were replaced with the new Reverse Power Relays by Energy Australia. The shutdown of units W1 and W3 was instead initiated by Boiler Master Fuel Trips.

SP AusNet advised that upon investigation, the Y protection scheme at YPS had operated to open the Auxiliary Transformer "A" 220 kV CB YPS/31 at YPS. The Y protection scheme at YWPS did not operate. The X protection scheme had not operated at either end. The Auxiliary Transformer 'A' 6.6 kV CB 21 and CB 61 at YWPS did not open nor were there related protection targets. Tests conducted later in the day the incident occurred did not identify any fault.

Table1: Summary of events as recorded by Energy Australia

Time	Event
14-Nov-12, 07:15:09	YWPS Aux Transformer 'A' 220 kV CB YPS/31 open
14-Nov-12, 07:17:06	W1 No.2 Bus 220kV CB (W1/33) Open
14-Nov-12, 07:17:16	W1 No.1 Bus 220kV CB (W1/34) Open
14-Nov-12, 07:23:32	W3 No.1 Bus 220kV CB (W3/38) Open
14-Nov-12, 07:23:42	W3 No.2 Bus 220kV CB (W3/37) Open
14-Nov-12, 16:25:20	The 220 kV line connecting the YWPS Auxiliary Transformer 'A' rendered available for service
14-Nov-12, 20:13:32	W3 No.2 Bus 220kV CB (W3/37) Close. YWPS unit W3 returned to service
14-Nov-12, 20:20:15	W3 No.1 Bus 220kV CB (W3/38) Close
15-Nov-12, 12:09:57	W1 No.1 Bus 220kV CB (W1/34) Close. YWPS unit W1 returned to service
15-Nov-12, 12:10:54	W1 No.2 Bus 220kV CB (W1/33) Close
16-Nov-12, (exact time not available)	YWPS Aux Transformer 'A' 220 kV CB YPS/31 Close

3.1 Post Contingent System Conditions

The status of the power system immediately after the incident is shown in Figure 2 and Figure 3. At YWPS, unit W4 was the only unit remaining in service after the incident. Incorrect data was telemetered to AEMO indicating that YWPS unit W4 was operating at zero output following the incident. Two dispatch intervals were affected and the market impact was not significant.

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

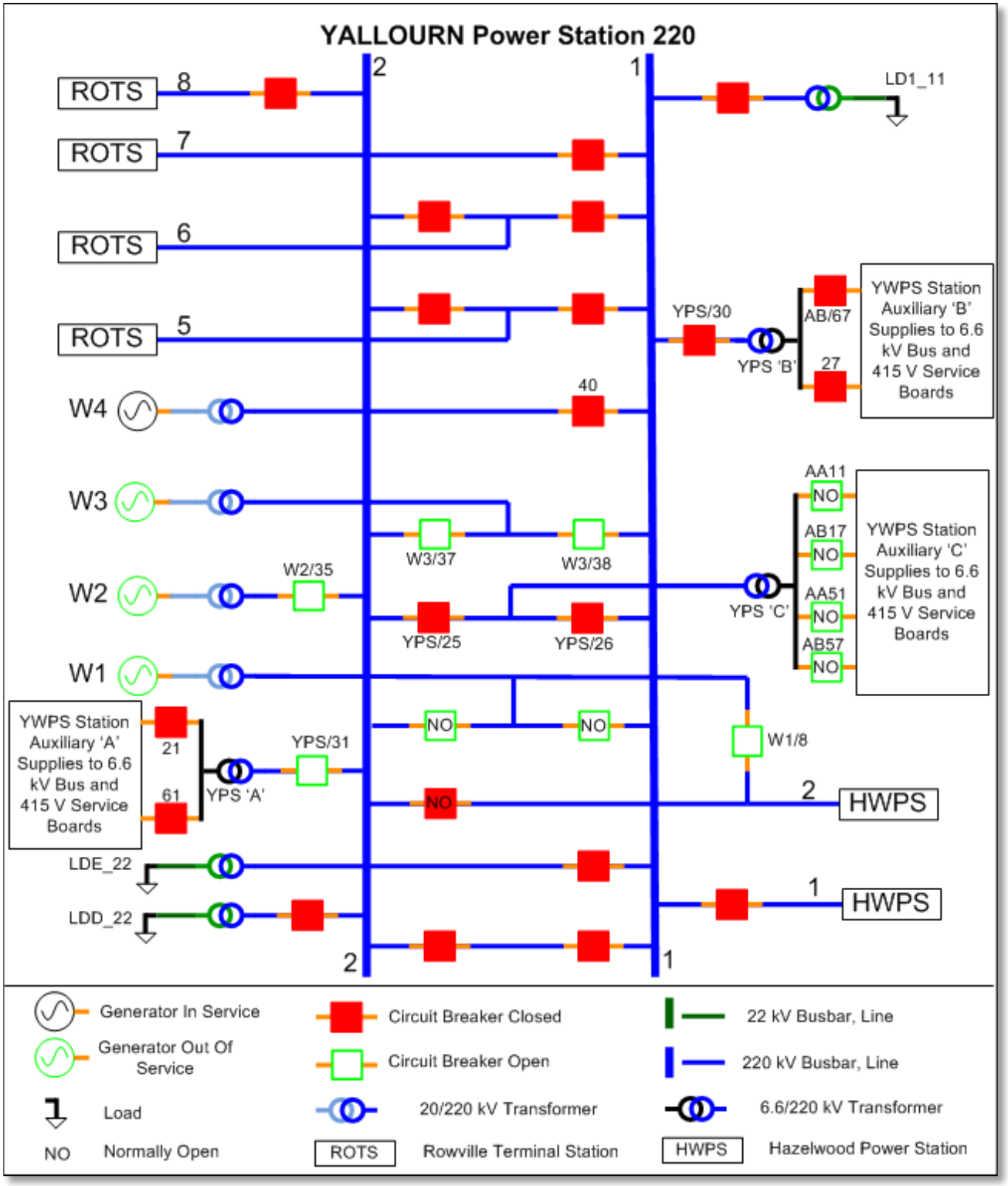
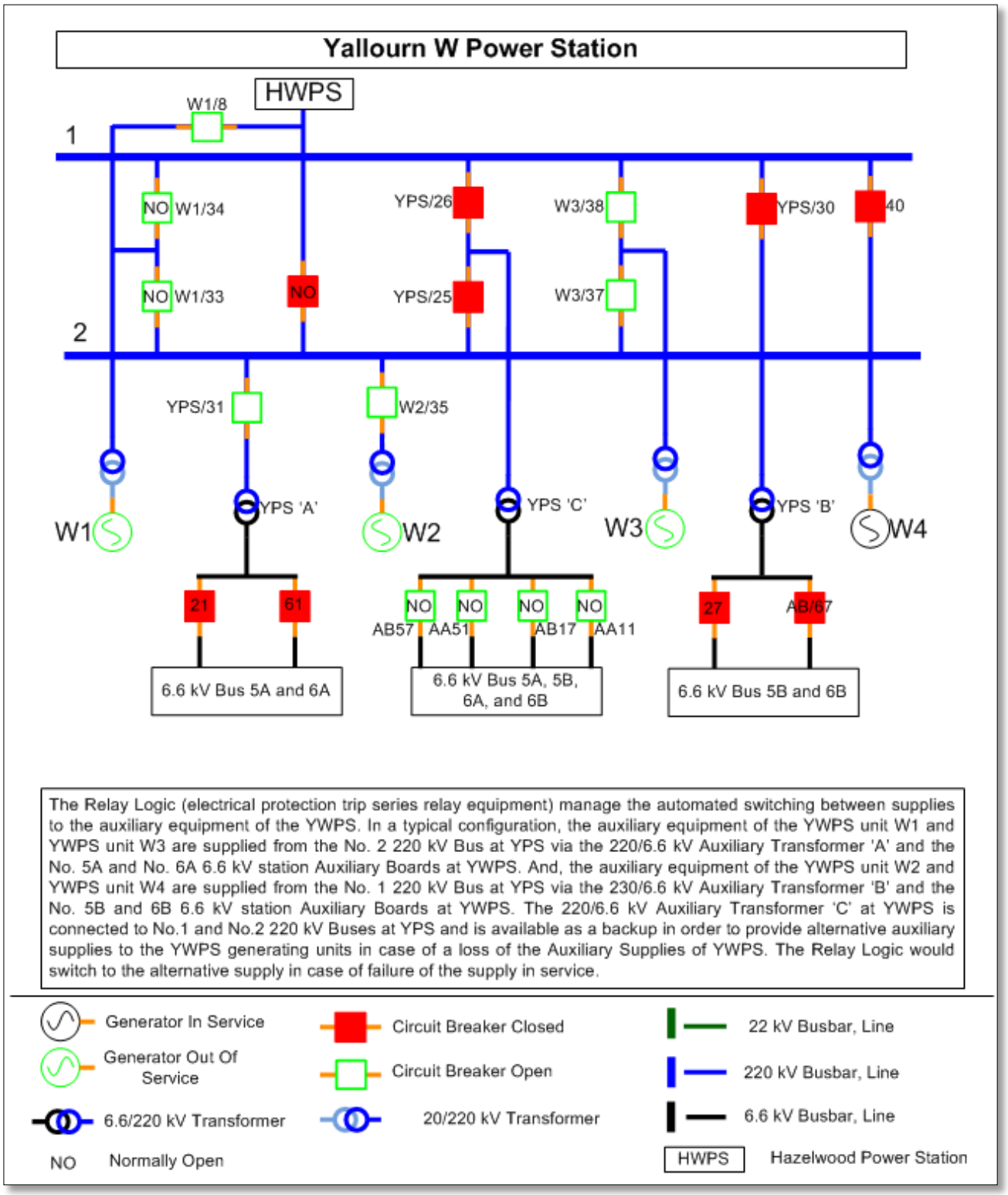


Figure 3: YWPS Auxiliary Supplies and the Distributed Control System



4 Immediate Actions Taken

At 0731 hours on 14 November, AEMO issued Electricity Market Notice No.40269 advising that Yallourn W Power Station unit W1 and unit W3 tripped for a total generation loss of approximately 753 MW.,At 1601 hours on 14 November, AEMO issued an Electricity Market Notice No. 40276

advising that, based on initial information provided by the Generator, AEMO will not be reclassifying this non - credible contingency event as a credible contingency event.

Unit W1 and unit W3 tripped due to interruption of the supplies to their auxiliary equipment. The Relay Logic is designed for an automatic changeover to alternate supplies for the auxiliary equipment from the 220/6.6 kV Auxiliary Transformer 'C' at YWPS. The Relay Logic automatic changeover to alternate supplies did not operate as it relies on the detection of an open status of the associated 6.6 kV CBs of the auxiliary transformers at YWPS (in this case, 6.6kV CBs 21 and 61 of V Auxiliary Transformer 'A' did not open).

SP AusNet advised that the 220 kV line connecting Auxiliary Transformer 'A' to the No. 2 220 kV Busbar at YPS had tripped but the reason was not yet known. SP AusNet performed comprehensive tests later in the day of the incident and advised that no cause of the fault was found with the circuit or its protections.

The 220 kV line connecting Auxiliary Transformer 'A' to the No. 2 220 kV Busbar at YPS was rendered available for service at 1625 hours on 14 November 2012. However, in consultation between SP AusNet and Energy Australia, the 220 kV CB YPS/31 at YPS was closed on 16/11/2012 after isolating the Y protection at YPS end.
At 2014 hours on 14 November 2012, unit W3 was returned to service. Auxiliary supplies were provided by the 220/6.6 kV Auxiliary Transformer 'C' at YWPS.
At 1210 hours on 15 November 2012, unit W1 was returned to service. Auxiliary supplies were provided by the 220/6.6 kV Auxiliary Transformer 'C' at YWPS.

5 Follow-up Actions

SP AusNet reported that comprehensive tests conducted on the day of the incident were carried out on the pilot wire protection. Current Transformer (CT) circuits were meggered[2] and continuity tests were carried out on the CT circuits. All the tests results were found to be satisfactory.

SP Ausnet also carried out; (a) loop resistance tests on the supervisory cable cores and (b) resistance to ground checks. No fault was found which would have caused the pilot wire relay at the YPS end to operate.

The line was rendered serviceable at 1625 hours on the same day. The Y protection at the YPS end was isolated and the line CB was closed on 16 November 2012. SP AusNet intends to carry out on load tests on the CTs and Pilot wires once Auxiliary Transformer 'A' is in service.

Following the event, Energy Australia left Auxiliary Transformer 'A' off-load for a trial period of approximately one week. SP AusNet in conjunction with Energy Australia conducted further investigation of the protection scheme ('Y' Pilot Wire Protection of the Auxiliary transformer 'A') by carrying out an on load test of Auxiliary Transformer 'A' on 14 January 2013. SP AusNet reported that the on load test results were satisfactory.

Energy Australia intends to review the Distributed Control System (DCS) logic design with a view to include functionality to auto reclose from an alternate supply on loss of supply from an Auxiliary Transformer.

Energy Australia advised that a preliminary review of DCS design has been undertaken to allow the DCS to perform automated changeover of station auxiliary supplies when a transformer is de-energised and not tripped. Energy Australia is aiming to complete the review by the end of March 2013.

Energy Australia also advised that the incorrect data telemetered to AEMO was caused by the failure of the Instrument Power Distribution supply to change over to an alternate supply because

[2] The Megger test is a method of measuring the electrical resistance, or friction of an electrical circuit using Ohmmeter. It will usually show the amount of moisture, the leakage current, the moist or dirty area of the insulation, and winding faults and deterioration.

the associated switches were not in the required position. The switches are now closed and alternative power supplies are now available. This is expected to address the issue relating to data telemetry.

6 Power System Security Assessment

The power system voltages and frequencies remained within the normal operating bands and the power system remained in a secure operating state throughout the incident. The incident did not cause any load interruptions, but as a result 753 MW of generation was lost (unit W1 and unit W3).

The trip of the multiple generating units at YWPS (unit W1 and unit W3) caused an excursion of the Mainland Frequency to a minimum of 49.75 Hz, which remained within the Mainland Frequency Operating Standards as the Mainland Frequency recovered to the normal operating band (49.85 Hz to 50.15 Hz) in 356 seconds[3]. The provision and response of the FCAS facilities and services available in Mainland region were adequate to maintain the Mainland Frequency within normal operating band to maintain the power system security.

7 Conclusions

At 0717 hours on 14 November 2012, S unit W1 and unit W3 tripped following interruption to supplies of their auxiliary equipment. This was caused by the de-energisation of Auxiliary Transformer 'A' when a pilot wire 'Y' protection scheme at YPS operated and opened the 220 kV CB (YPS/31) at YPS. However, the Relay Logic at YWPS did not automatically transfer to an alternative auxiliary supply on loss of the supply from Auxiliary Transformer 'A' because the logic criterion for this to occur was not met. SP AusNet carried out all tests although no fault was found in the 'Y' Protection of the line connecting Auxiliary transformer 'A' to the No. 2 220 kV Busbar at YPS. Although this line was made available for service at 1625 hours on 14 November 2012 the 220 kV CB (YPS/31) at YPS was not closed until 16 November 2012.

AEMO is satisfied that SP AusNet has carried out the appropriate work to mitigate the risk of tripping 'Y' protection for the 220 kV line connecting Auxiliary Transformer 'A' to the No. 2 220 kV Busbar at YPS.

AEMO is satisfied that Energy Australia intends to review the DCS logic design to initiate the automated switchover to alternative Auxiliary Supplies in case the loss of in service supplies to avoid similar incidents in future.

Unit W3 and unit W1, returned to service at 2014 hours on 14 November 2012 and 1210 hours on 15 November 2012 respectively.

AEMO is satisfied that Energy Australia and SP AusNet have carried out the appropriate work for the adequacy of the provision and response of facilities and services and have taken appropriate actions to restore and maintain power system security.

AEMO correctly applied the criteria published in section 12 of its Power System Security Guidelines in assessing that the circumstances of this incident did not warrant reclassifying similar incidents as a credible contingency event.

8 Recommendations

By 31 March 2013, Energy Australia is to advise AEMO of the outcome of their review of the DCS and any changes made.

[3] The Frequency Operating Standard for a multiple contingency event in the NEM Mainland is a containment band of 47 to 52 Hz and recovery to the frequency band of 49.85 to 50.15 Hz within 10 minutes.