Power System Operating Incident Report – Trip of Rowville-Yallourn No.8 220 kV Transmission Line and Multiple Wind Farms on 5 January 2014

PREPARED BY: AEMO Systems Capability

DATE: 4 April 2014

STATUS: FINAL

Contents

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Version Release History

VERSION	DATE	BY	CHANGES	CHECKED BY	AUTHORISED BY
1	4 April 2014	J Duque	FINAL	S Darnell	P Biddle

Incident Classifications

Time and date and of incident	0949 hrs Sunday 5 January 2014
Region of incident	VIC
Affected regions	VIC
Event type	TG – Loss of transmission elements and generating units
Primary cause	TE – Transmission equipment failure
Impact	Significant
Associated reports	Power System Operating Incident Report – Trip of Ringwood – Rowville 220 kV Transmission Line and Multiple Generating units on 29 September 2013. Power System Operating Incident Report – Trip of Rowville – Thomastown 220 kV Transmission Line and Multiple Wind Farms on 13 October 2013.

Abbreviations

Abbreviation	Term
AEMO	Australian Energy Market Operator
EMMS	Electricity Market Management System
EMS	Energy Management System
GPS	Generator Performance Standards
kV	Kilovolt
MW	Megawatt
NER	National Electricity Rules
PPC	Power Plant Controller
ROTS	Rowville Terminal Station

1 Introduction

This report reviews a power system operating incident that occurred on 5 January 2014 in Victoria. 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 SP AusNet[3], Powercor[4], AGL[5], Acciona Energy[6]and Goldwind Australia[7]. 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 Sunday 5 January 2014, at 0949 hrs, the Rowville – Yallourn No.8 220 kV Transmission Line tripped, reclosed and tripped again. Simultaneously, Oaklands Hill and Mortons Lane Wind Farms tripped from 54 MW and 20 MW respectively, and Macarthur and Waubra Wind Farms reduced generation for a short period by 24 MW and 43 MW respectively. Generation reduced by a total of 141 MW. SP AusNet then patrolled the line but found no evidence of a fault.

Mortons Lane Wind Farm returned to service at 1015 hrs and Oaklands Hill Wind Farm at 1257 hrs.

At 1356 hrs SP AusNet attempted to re-energise the line. This attempt failed and simultaneously tripped Oaklands Hill and Mortons Lane Wind Farms from 54 MW and 17 MW respectively, and reduced generation at Waubra Wind Farm by 31 MW. Generation reduced by a total of 102 MW.

Oaklands Hill Wind Farm returned to service again at 1826 hrs and Mortons Lane Wind Farm at approximately 1834 hrs.

No load was lost as a result of this incident.

The reason for investigating this incident is that multiple generators tripped as a result of a power system fault. Generally for a power system fault, generating units are required to remain connected to the power system whilst protection systems react and clear the fault.

3 Participant Investigation

The incident was investigated by the entities affected by the transmission fault and the resulting power system disturbance. This section summarises the findings of these investigations.

[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] SP AusNet is the Transmission Network Service Provider (TNSP) in Victoria. 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).

[4] Powercor is the distribution network service provider for Oakland Hill and Mortons Lane Wind Farms

[5] AGL Hydro Partnership is the Registered Participant of Oaklands Hill and Macarthur Wind Farms.

[6] Acciona Energy is the operator of Waubra Wind Farm.

[7] Goldwind Australia is the operator of Mortons Lane Wind Farm

3.1 SP AusNet – Transmission Network Service Provider

SP AusNet identified that the initial fault was a White phase to earth fault[8] on the Rowville – Yallourn No.8 220 kV line. This was detected by X and Y protection at both line ends. The trip was followed by a single ended auto reclose operation at Rowville Terminal Station, which reclosed onto the same white phase to earth fault and tripped.

SP AusNet's initial interpretation of protection relay data was that the fault location was approximately 33 km from the Yallourn Power Station end of the line. SP AusNet then patrolled the relevant area but found no evidence of a fault. SP AusNet then attempted to re-energise the line but the line again tripped.

SP AusNet further reviewed protection relay data and then patrolled the line from the Rowville Terminal Station end. The patrol found a failed bridging conductor on one of the towers approximately 450m from Rowville Terminal station. SP AusNet rectified the failed bridging conductor and retuned the line to service at 1830 hrs on the same day.

3.2 Oaklands Hill (AGL), Mortons Lane (Goldwind Australia) and Powercor

Oaklands Hill Wind Farm (AGL) and Mortons Lane Wind Farm (Goldwind Australia) tripped from 54 MW and 20 MW respectively at the same time as the transmission line fault.

AGL, Goldwind Australia and Powercor suspect that the cause of the wind farm trips was an unidentified transient overvoltage on the distribution network. The overvoltage triggered the operation of a Powercor overvoltage protection relay at Nareeb Switching Station which in turn tripped Oaklands Hill and Mortons Lane Wind Farms.

Similar incidents occurred on 29 September and 13 October 2013. Powercor have been unable to identify the source of the overvoltage on the distribution network for the previous incidents or this incident.

On 8 January 2014 Powercor extended the time delay of their overvoltage protection relays at Nareeb Switching Station, Mortons Lane Wind Farm and Oaklands Hill Wind Farm. The intent of the modification is to allow the STATCOM[9] sufficient (more) time to respond to an overvoltage and thereby prevent the wind farms tripping due to short transient overvoltages.

Following the overvoltage relay modification by Powercor, AEMO cancelled the outstanding generator non-compliance on Oaklands Hill Wind Farm[10], and issued Market Notice 44460 removing Oaklands Hill Wind Farm and Mortons Lane Wind Farm from the reclassification issued in Market Notice 44412[11].

The performance of Mortons Lane Wind Farm during this incident was in accordance with the information registered in its Generator Performance Standards.

3.3 Macarthur (AGL)

Macarthur Wind Farm reduced generation by 24 MW following the fault. Initially, there was an instantaneous drop in the power output of the wind farm. The reason for this power reduction is as yet unknown. AGL believes that this reduction was then followed by a response from the Wind Farm Power Plant Controller (PPC) - due to the power system fault - to recover voltage. This response caused a high current flow to the turbines which then tripped three turbines[12]. The three turbine trips exacerbated the initial reduction in output power of the wind farm.

[8] The Appendix of this report contains graphics associated with this event.

[9] A static compensator (STATCOM) is a device used to manage voltage via use of reactive power.

[10] AGL declared Oaklands Hill Wind Farm non-compliant on 15/11/2013 as a result of a similar incident on 29/09/2013.

[11] This reclassification was initiated due the event on 29 September 2013 and has been modified several times to include or remove generating units according to the latest available information.

[12] The turbines tripped on high machine side converter current

AGL's investigation suggested that the trip of the three turbines was the result of the correct operation of the protection system under the fault conditions. Based on that information AEMO issued Market Notice 45440 removing Macarthur Wind Farm from the reclassification issued in Market Notice 44460.

AGL has further investigated the response of the PPC and has subsequently upgraded the PPC software. The upgrade will smooth transition from Low Voltage Ride Through (LVRT) mode to Voltage Control mode. This is expected to improve the turbine response to similar events.

3.4 Acciona Energy (Waubra)

At Waubra Wind Farm nine turbines tripped as a result of this incident. Acciona Energy declared the nine turbines as non-compliant with their Generator Performance Standards (GPS). The cause of the trip of the nine turbines remains under investigation. Once the investigation concludes Acciona Energy will submit the results to AEMO, via the GPS Non-Compliance process, for power system security assessment. This submission is expected by 17 July 2014.

4 System Diagrams

The status of the power system before and after the incident is shown in Figures 1 and 2. For clarity only equipment relevant to this incident has been included in the diagrams. The diagrams show the network and the generating units affected by the events.

5 Incident Event Log

The sequence of events comprising the incident are itemised in Table 1.

6 Immediate Actions

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

AEMO invoked constraint set V-ROYP78 at 1000 hrs approximately 10 minutes after the incident. This action ensured that the power system was in a secure operating state[13].

No further actions were required to maintain power system security.

7 Follow-up Actions

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

At 1133 hrs AEMO issued Market Notice 44413 to notify the Market of the non-credible contingency event14.

At 1250 hrs AEMO issued Market Notice 44412 to modify the reclassification15 of a non-credible contingency event issued in Market Notice 4420416. The new reclassification included the trip of Oaklands

[13] 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)).

[14] This was within two hours of the event - 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

[15] For a non credible contingency 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 4.8.15 (ca). AEMO has to determine if the condition that caused the non-credible contingency event has been resolved.

[16] This reclassification was initiated due the event on 29 September in Victoria and has been modified several times to include or remove generating units according to the latest information at the time.

Figure 1 - Before the incident

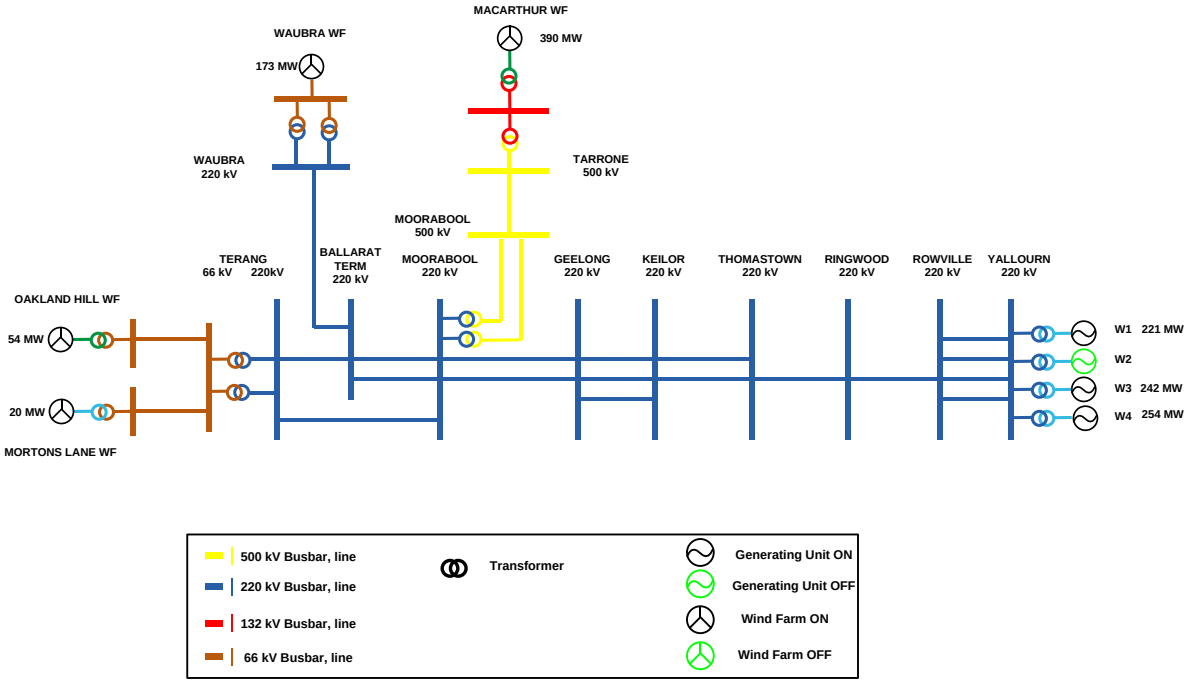

Figure 2 - After the incident

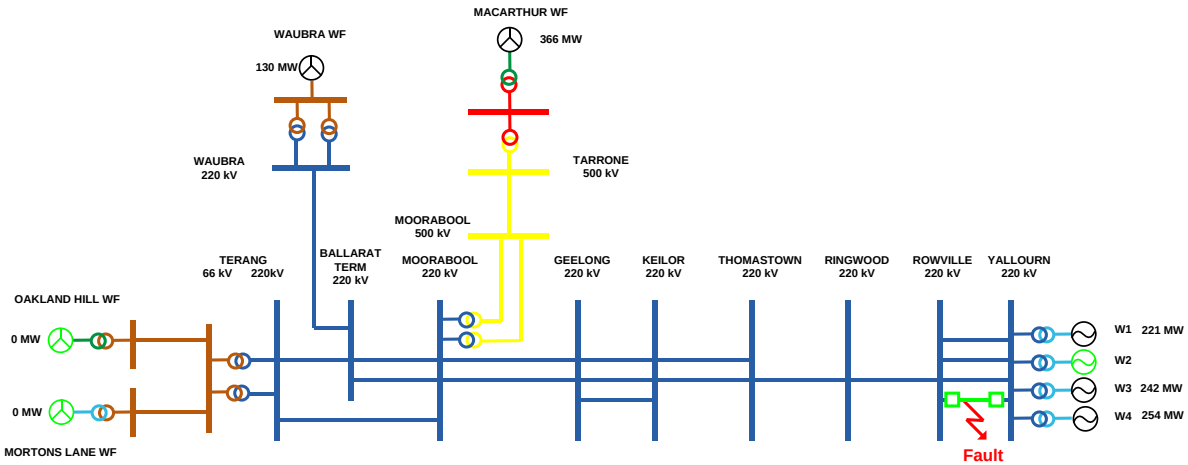

Table 1 – Event Log

Time and Date	Event
09:49 05 Jan 2014	Rowville – Yallourn No.8 220 kV Transmission Line tripped/reclosed/tripped Oaklands Hill and Mortons Lane Wind Farms tripped from 54 MW and 20 MW respectively Macarthur and Waubra Wind Farms reduced generation by 24 MW and 43 MW respectively Total wind farm reduction 141 MW
10:00 05 Jan 2014	Constraint set V-ROYP78[17] invoked
10:15 05 Jan 2014	Mortons Lane Wind Farm returned to service.
11:33 05 Jan 2014	AEMO issued Market Notice 44413 to notify the market of the non-credible contingency event
12:50 05 Jan 2014	AEMO issued Market Notice 44412 to modify the reclassification of a non-credible contingency event informed on Market Notice 44204
12:57 05 Jan 2014	Oaklands Hill Wind Farm returned to service.
13:56 05 Jan 2014	Following line patrol (no fault found), SP AusNet attempted and failed to re-energize the Rowville – Yallourn No.8 220 kV Transmission Line Oakland Hill and Mortons Lake Wind Farm from tripped from 54 MW and 17 MW respectively Waubra Wind Farm reduced by 31 MW Total wind farm reduction 102 MW
15:24 05 Jan 2014	A second line patrol found failed bridging conductor on tower 342 (3 towers from Rowville Terminal Station).
16:02 05 Jan 2014	AEMO issued Market Notice 44420 informing the market about the failed attempt to energise the Rowville – Yallourn No.8 220 kV Transmission Line, and the loss of generation associated with that event.
18:26 05 Jan 2014	Oaklands Hill Wind Farm Wind Farm returned to service.
18:34 05 Jan 2014	Mortons Lane Wind Farm returned to service.
18:38 05 Jan 2014	Rowville – Yallourn No.8 220 kV Transmission line repaired and returned to service.
18:45 05 Jan 2014	Constraint set V-ROYP78 revoked.
20:14 10 Jan 2014	AEMO issued Market Notice 44460 to remove Oaklands Hill Wind Farm from the reclassification issued in Market Notice 44412. Powercor had informed AEMO that the overvoltage protection settings had been modified.
11:20 25 Mar 2014	AEMO issued Market Notice 45440 removing Macarthur Wind Farm from the reclassification issued in Market Notice 44460. AGL had informed AEMO that the trip of three turbines at Macarthur Wind Farm was due to the correct operation of the protection systems to protect the turbines.

[17] Constraint set for the outage of Rowville – Yallourn 220 No.7 or No.8 220 kV lines.

Hill and Mortons Lane Wind Farms and reduction on generation at Macarthur and Waubra Wind Farms for faults on the 220 kV transmission network.

SP AusNet identified that the initial fault was a White phase to earth fault[18] on the Rowville – Yallourn No.8 220 kV line. SP AusNet patrolled a section of line from the Yallourn end but found no evidence of a fault. SP AusNet then attempted to reenergise the line but the line again tripped.

AEMO then issued Market Notice 44420 at 1602 hrs to inform the market of the loss of generation associated with this failed reclose.

SP AusNet further reviewed protection relay data and then patrolled a section of line from the Rowville end. The patrol found a failed bridging conductor close to Rowville Terminal Station. SP AusNet rectified the failed bridging conductor and retuned the line to service at 1830 hrs on the same day.

8 Power System Security

This section assesses how AEMO managed power system security over the course of the incident[19].

For this incident the power system remained secure over the course of the incident. Power system frequency, and voltage remained within limits and the faults were cleared within required timeframes. AEMO notified the Market of both events within the required timeframe[20], and correctly assessed and reclassified the incident as a credible contingency.

9 Conclusions

1. A failed bridging conductor on a tower close to Rowville Terminal Station caused the Rowville – Yallourn No.8 220 kV Transmission Line to trip.
2. Oaklands Hill and Mortons Lane Wind Farms tripped due to the operation of a Powercor overvoltage protection system at Nareeb switching station. Remedial action has been taken to prevent this type of event reoccurring.
3. At Macarthur Wind Farm, AGL has further investigated the response of the PPC and has carried out software upgrade to improve the response the wind farm to similar events.
4. At Waubra Wind Farm, the trip of the turbines remains under investigation. Acciona will submit the results of the investigation to AEMO via the GPS non-compliance process by 14 July 2014.
5. Power system security was maintained over the course of the incident

10 Pending Actions

1. Acciona Energy to submit the results of the investigation to AEMO via the GPS non-compliance process, by 14 July 2014.

11 Recommendations

There are no recommendations arising from this review.

[18] Figure A1 (in Appendix 1) shows the phase voltages at Rowville Terminal Station (ROTS) on exit to Hazelwood Power Station (HWPS) during the initial event.

[19] 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.

[20] AEMO, *Power System Security Guidelines,* v56 Section 10.3

12 Appendix – Voltage and Frequency Plots at Rowville Terminal Station (ROTS)

Figure A1 – Frequency and Voltage at Rowville Terminal Station (initial trip/reclose/trip)

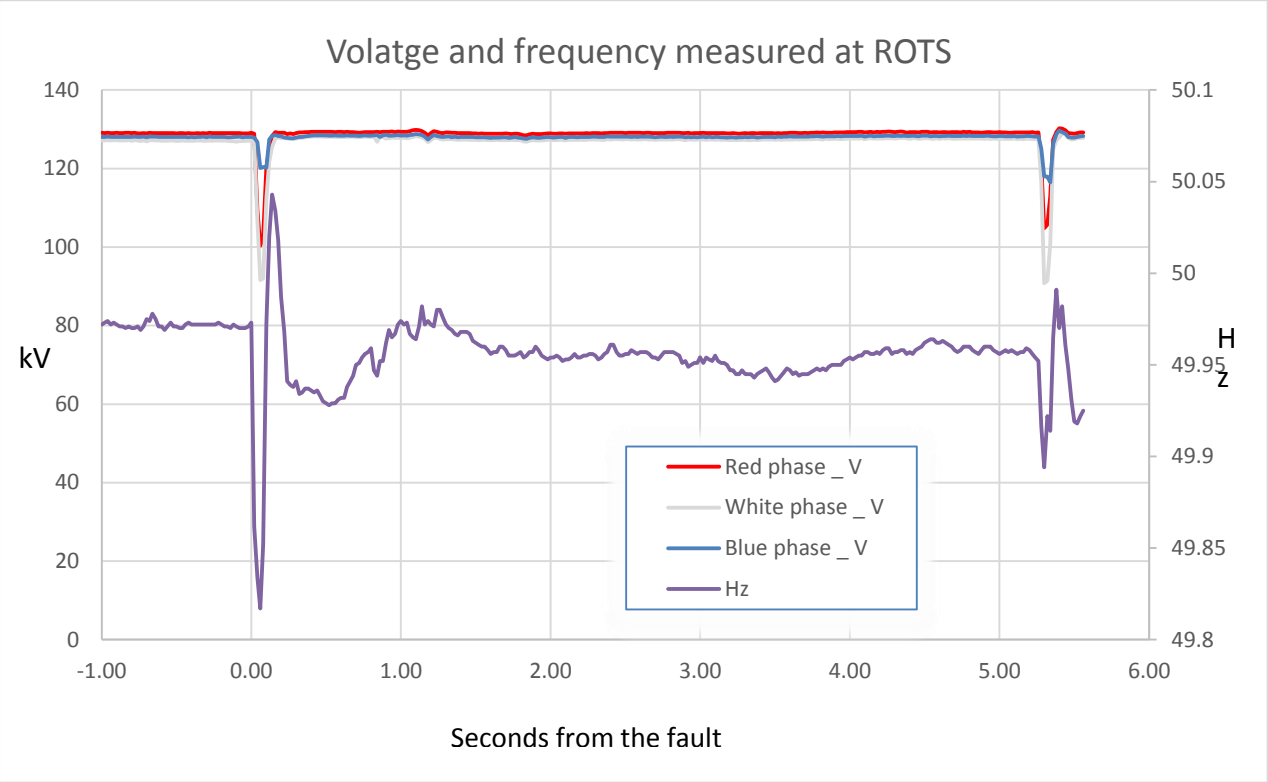

Figure A2 – Frequency and Voltage at Rowville Terminal Station (initial trip)

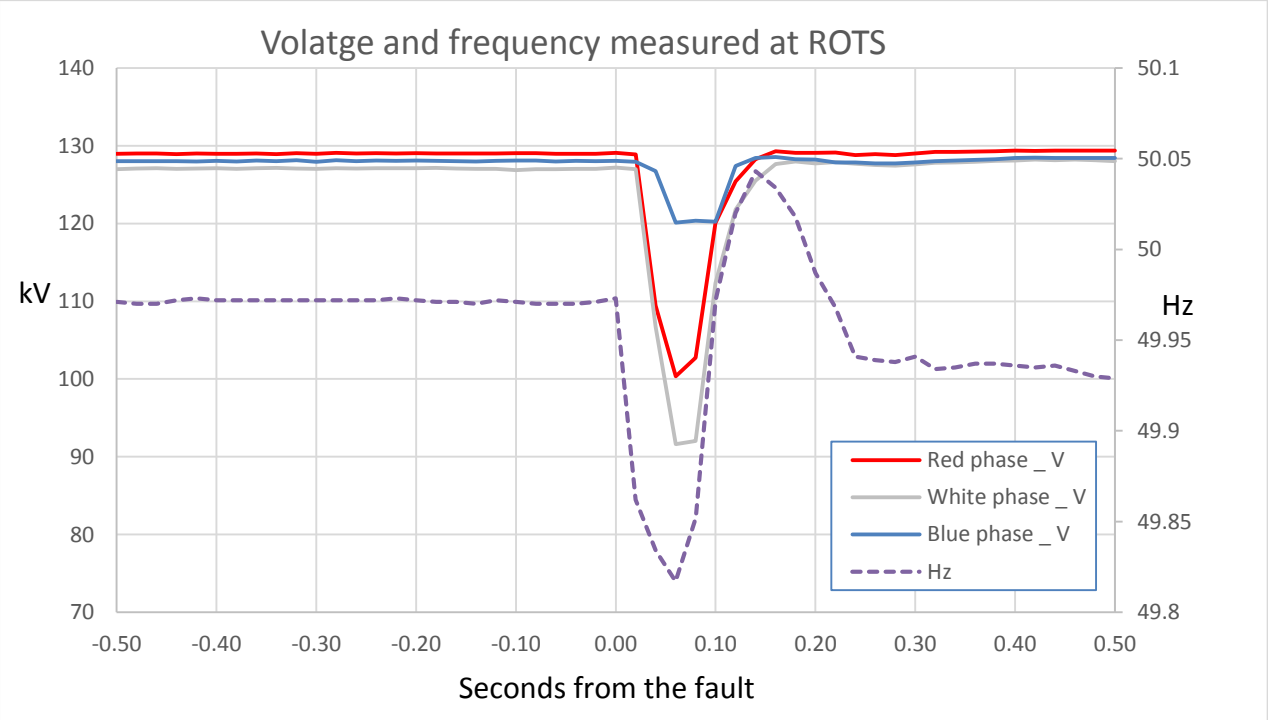

Figure A3 – System Frequency 4 sec data during the initial fault (09:49 hrs)

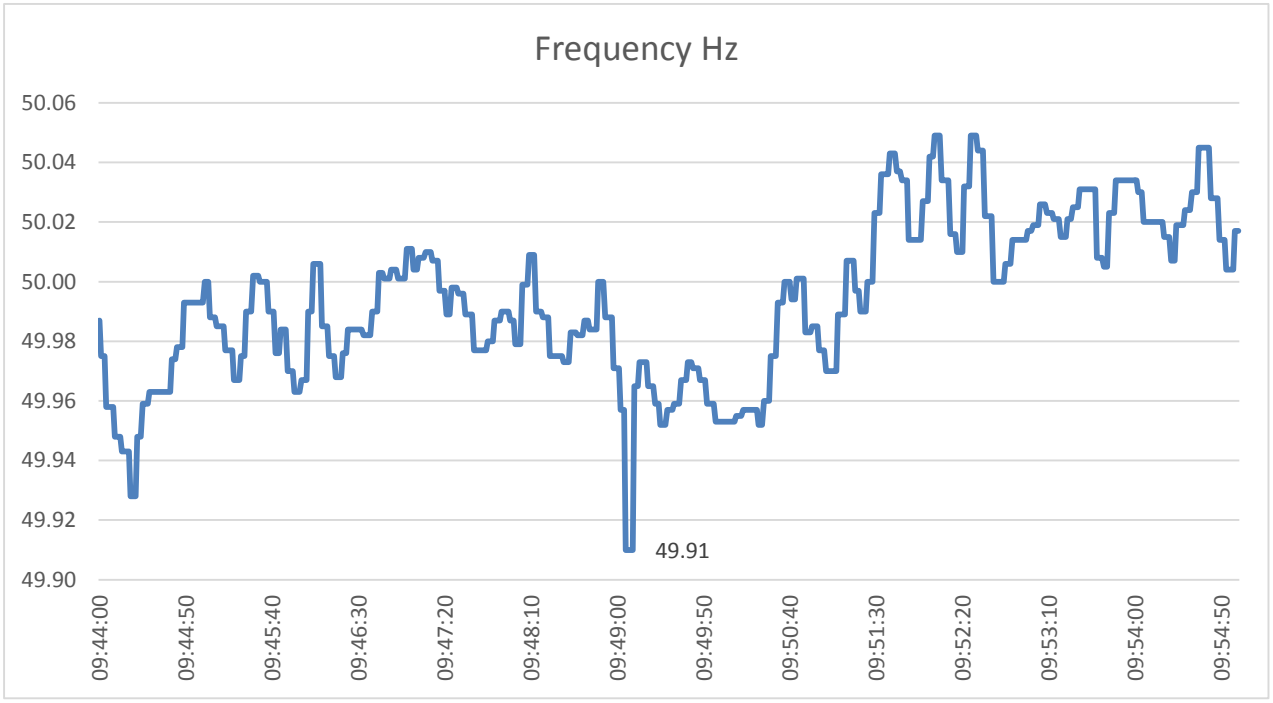

Figure A4 – System Frequency 4 sec data during the Second fault (13:56 hrs)