

PRELIMINARY REPORT ON TOTAL SYSTEM
FAILURE
AT 1230 HRS ON 17th AUGUST 2020

Control & Protection Branch,
Transmission Division,
Ceylon Electricity Board,
Kent Road,
COLOMBO 00900
Date: 20.08.2020

PRELIMINARY REPORT ON TOTAL SYSTEM FAILURE
AT 1230 HRS ON 17th AUGUST 2020

1. INTRODUCTION

A total failure occurred at 1230 hrs on 17th August 2020 involving all transmission lines, Power Stations and Grid Substations in the power system in Sri Lanka.

2. DATE/TIME OF THE FAILURE

Date : 17th August 2020

Time : At 1230 hrs

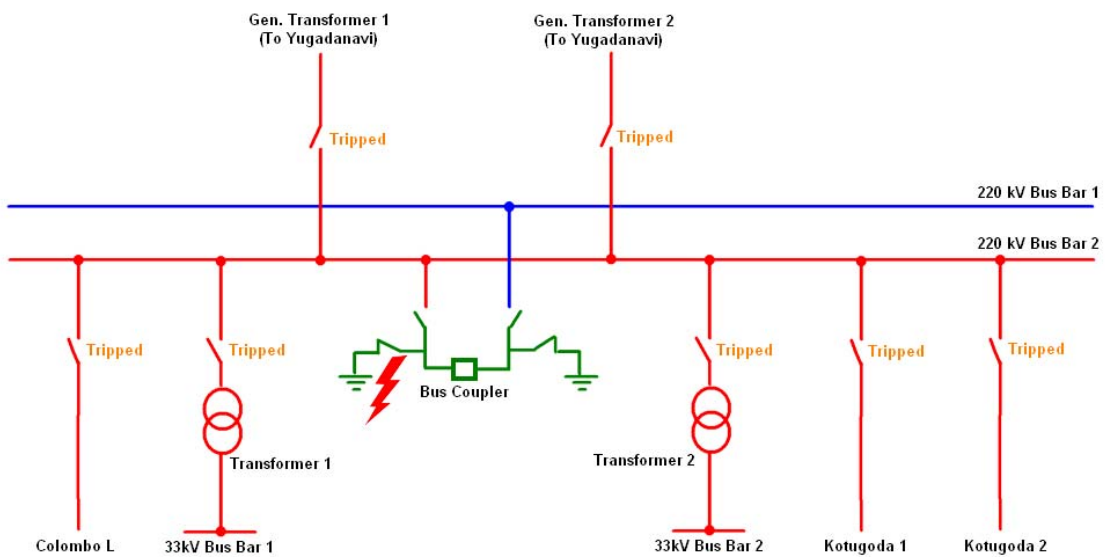


Figure 01: Busbar arrangement of Kerawalapitiya 220kV GIS during the fault

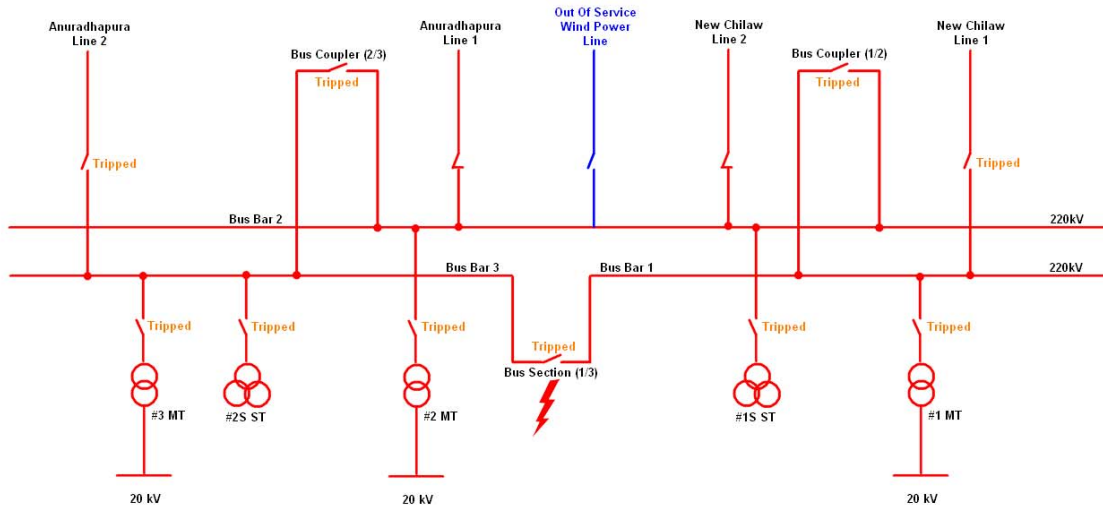


Figure 02: Busbar arrangement of Lakvijaya 220kV GIS during the fault

3. EQUIPMENT TRIPPINGS AND RELAY INDICATIONS

Kerawalapitiya Grid Substation

Equipment Trippings	Relay Type	Relay indications	Trip Time
Kerawalapitiya Transformer 02 (220/ 33 kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.150 hrs
Kerawalapitiya Transformer 01 (220/ 33 kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.154 hrs
Kerawalapitiya-Kotugoda Transmission Line 02 (220kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.162 hrs
Yugadhanavi Power Plant Generator Transformer 02 (220/ 14.5 kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.164 hrs
Kerawalapitiya-Kotugoda Transmission Line 01 (220kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.166 hrs
Yugadhanavi Power Plant Generator Transformer 01 (220/ 14.5 kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.168 hrs
Kerawalapitiya-Colombo L Transmission Line (220 kV)	SIEMENS 7SS522/7SS523	BB Protection Operated	12:30:27.172 hrs
Bus Coupler (220kV)	SIEMENS 7SS522/7SS523	Outage	-

Lakvijaya Power Station

Equipment Trippings	Relay Type	Relay indications	Trip Time
Lakvijaya Generator Transformer 03 (220/ 20 kV)			12:30:27.359 hrs
Lakvijaya Generator Transformer 02 (220/ 20 kV)			12:30:27.390 hrs
Lakvijaya Bus Coupler 2/3 (220kV)	SAC PSL631A	BB Protection Operated	12:30:27.423 hrs
Lakvijaya Bus Section 1/3 (220 kV)	SAC PSL631A	BB Protection Operated	12:30:27.423 hrs
Lakvijaya Generator Transformer 01 (220/ 20 kV)			12:30:27.429 hrs
Lakvijaya Bus Coupler 1/2 (220kV)	SAC PSL631A	BB Protection Operated	12:30:27.452 hrs
Lakvijaya – Busbar Protection	Panel A NR - 915 Panel B SAC -SGB750	BB Protection Operated	12.30.27.458 hrs
Lakvijaya-New Chilaw Transmission Line 01 (Veyangoda Line 01) (220 kV)	Panel A NR – RCS 931 Panel B SAC PSL 602GCM	BB Protection Operated	12:30:27.478 hrs
Lakvijaya-New Anuradhapura Transmission Line 02 (220 kV)	Panel A NR RCS 931 Panel B SAC PSL 602GCM	BB Protection Operated	12:30:27.480 hrs
Lakvijaya-New Anuradhapura Transmission Line 01 (220 kV)	Panel A NR RCS 931 Panel B SAC PSL 602GCM	No Trip	-
Wind Power Line (220 kV)	SAC PSE121	Out of Service	-
Lakvijaya-New Chilaw Transmission Line 02 (Veyangoda Line 02) (220 kV)	Panel A NR RCS 931 Panel B SAC PSL 602GCM	No Trip	-

4. DDR RECORDS

Disturbance records from DDRs installed at Kerawalapitiya GIS, Sub L, Kotugoda, Veyangoda, New Chilaw GSS, Kothmale PS & Lakvijaya PS were obtained for analysis.

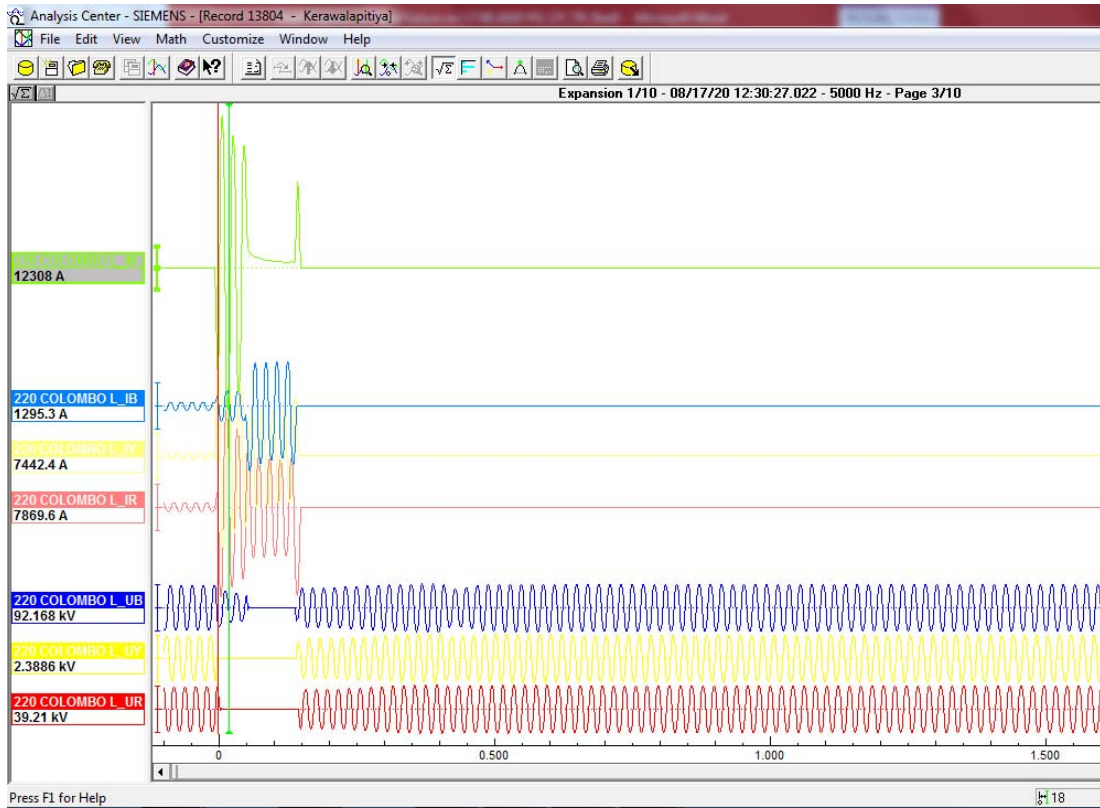


Figure 03: DDR record of Sub L bay of 220kV Kerawalapitiya GIS at 12:30:27 Hrs

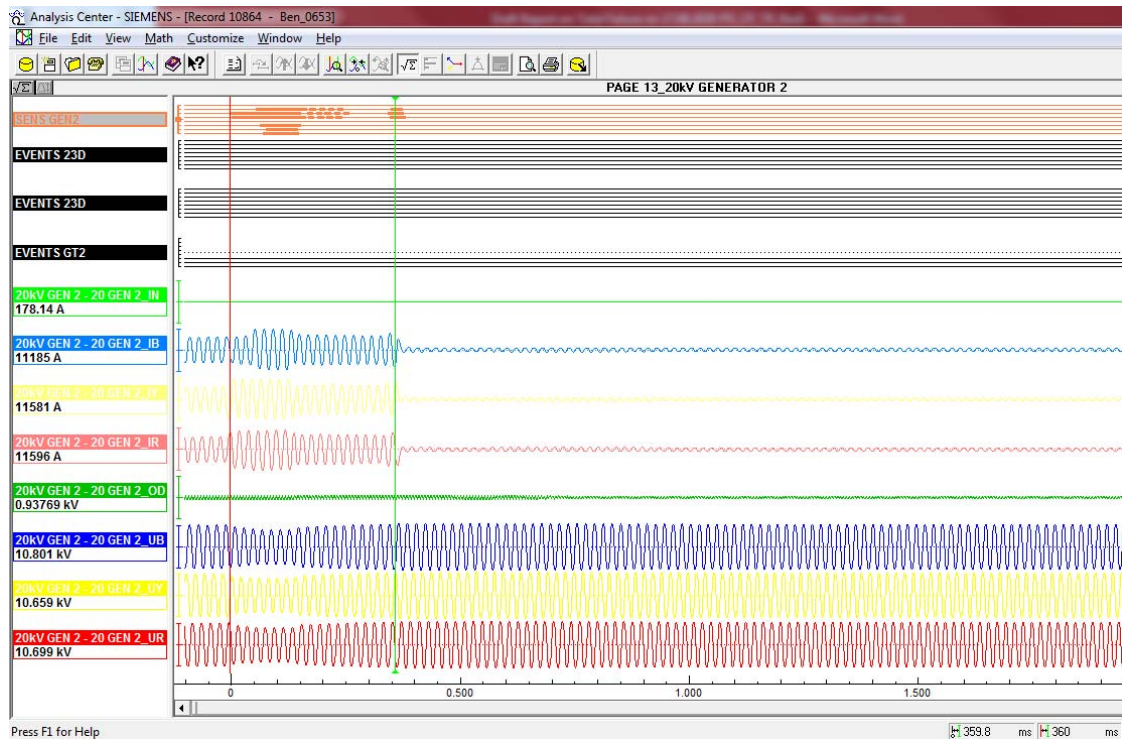


Figure 04: DDR record of Generator 2 bay of 220kV Lakvijaya GIS at 12:30:27 Hrs

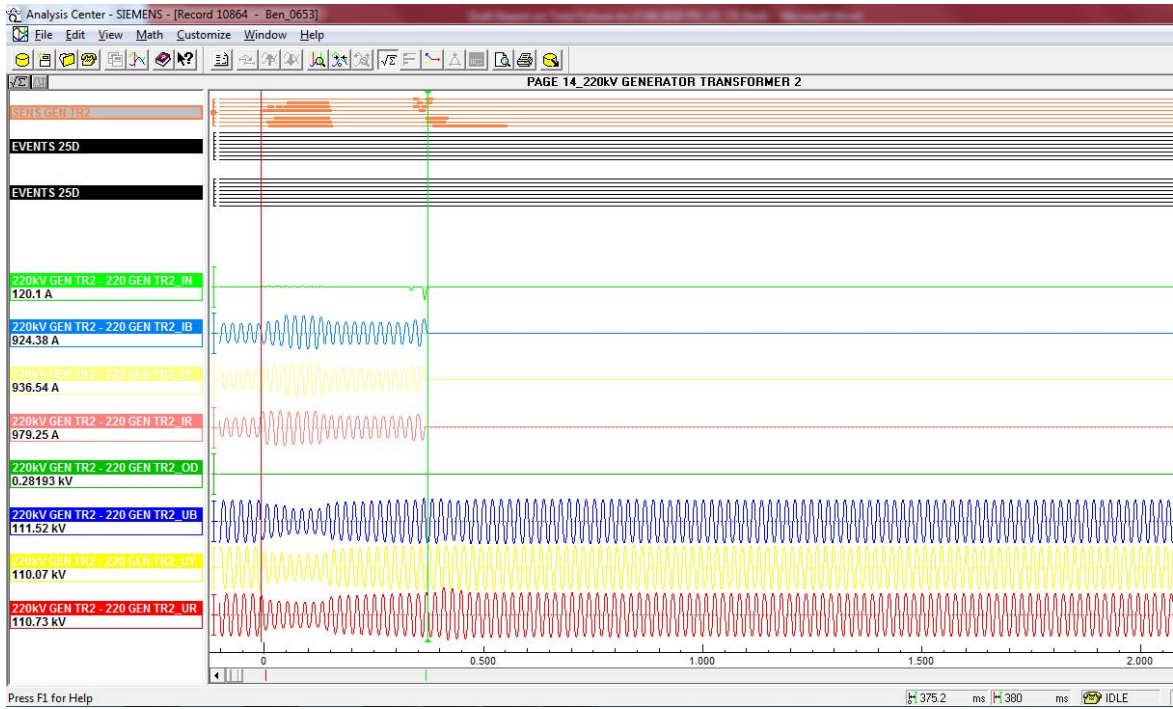


Figure 05: DDR record of Generator Transformer 2 bay of 220kV Lakvijaya GIS at 12:30:27 Hrs

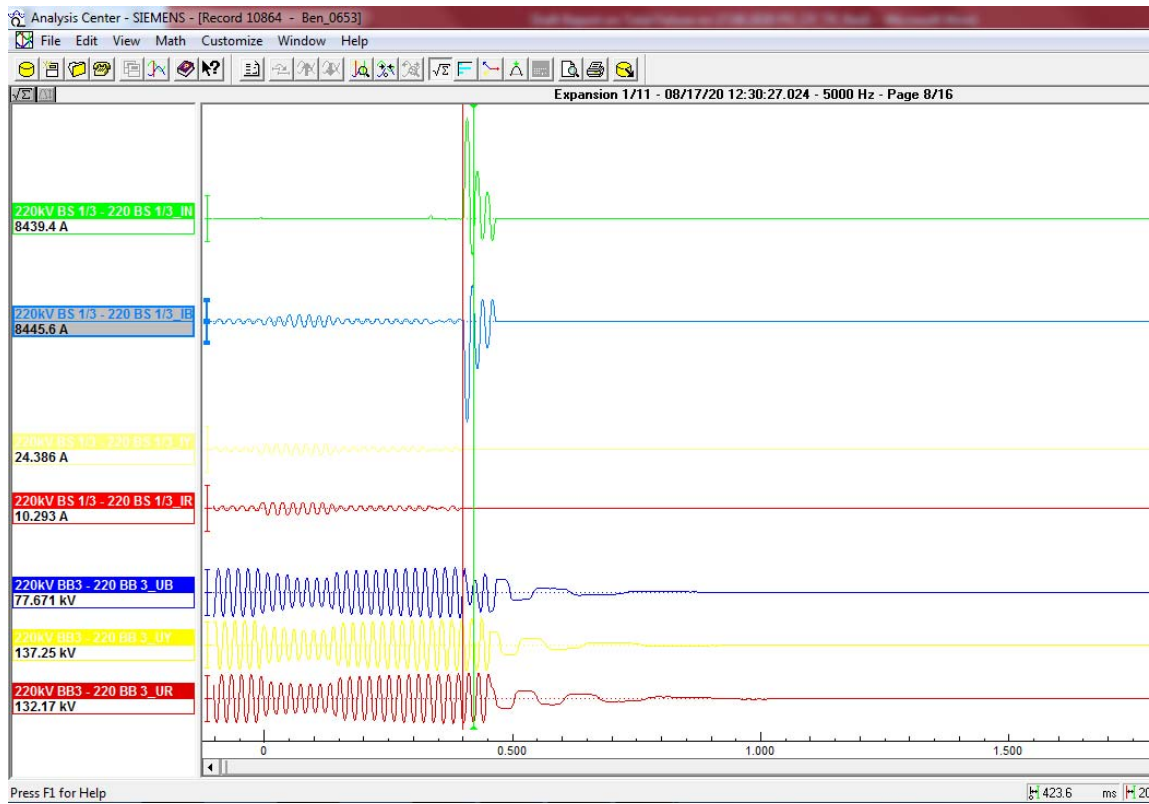


Figure 06: DDR record of Bus section 1/3 bay of 220kV Lakvijaya GIS at 12:30:27 Hrs

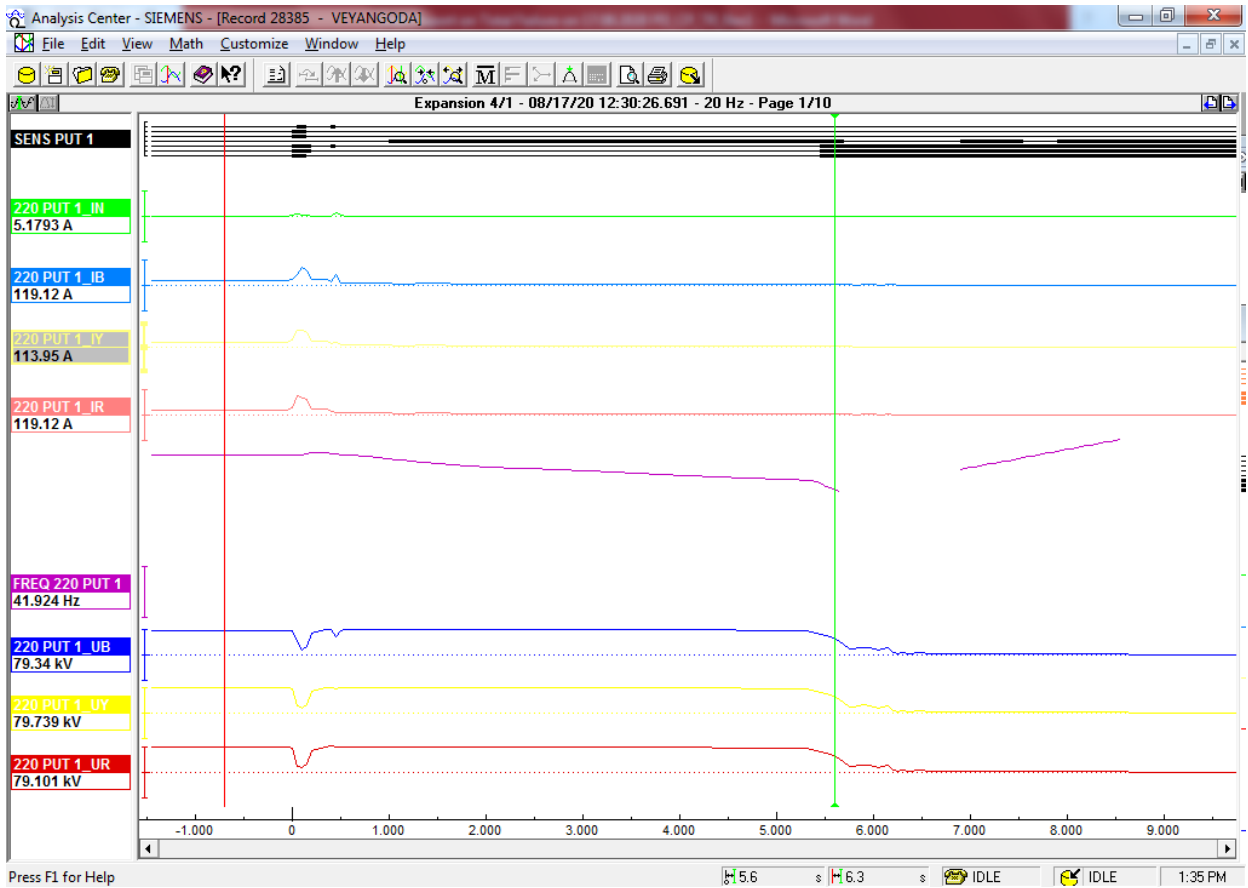


Figure 07: Frequency variation at Veyangoda 220kV Bus

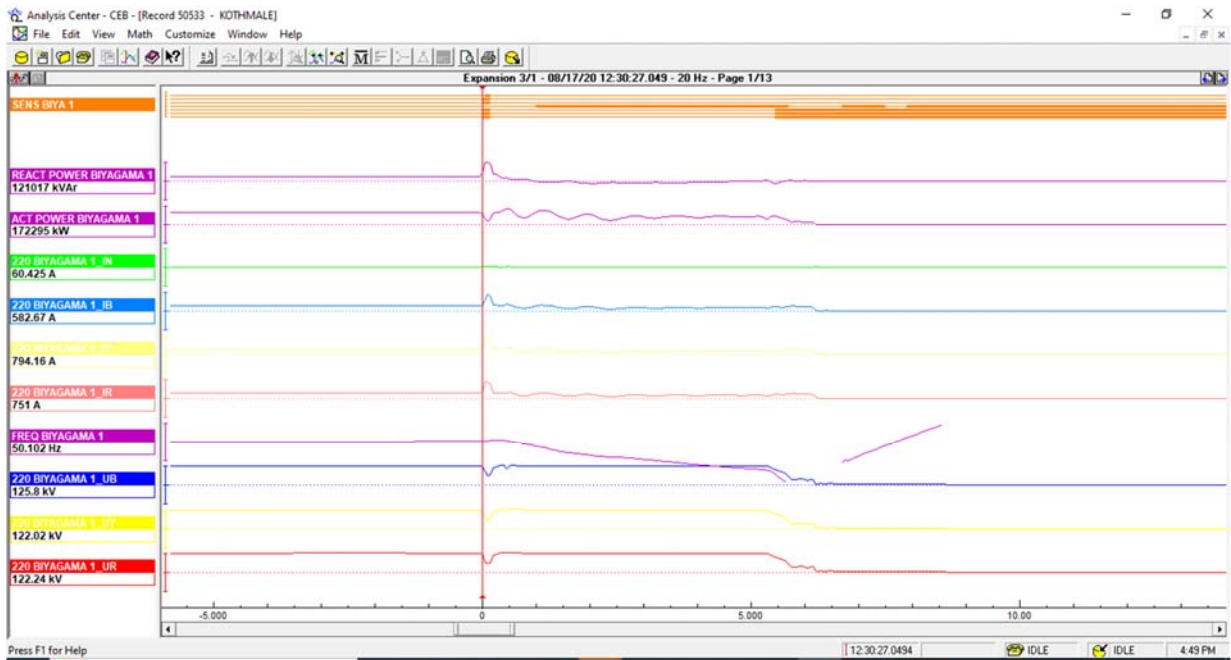


Figure 08: Frequency variation at Kothmale 220kV Bus

5. OBSERVATIONS AND ANALYSIS

The frequency variation during the system failure plotted using DDR of Kothmale Power Station as follows.

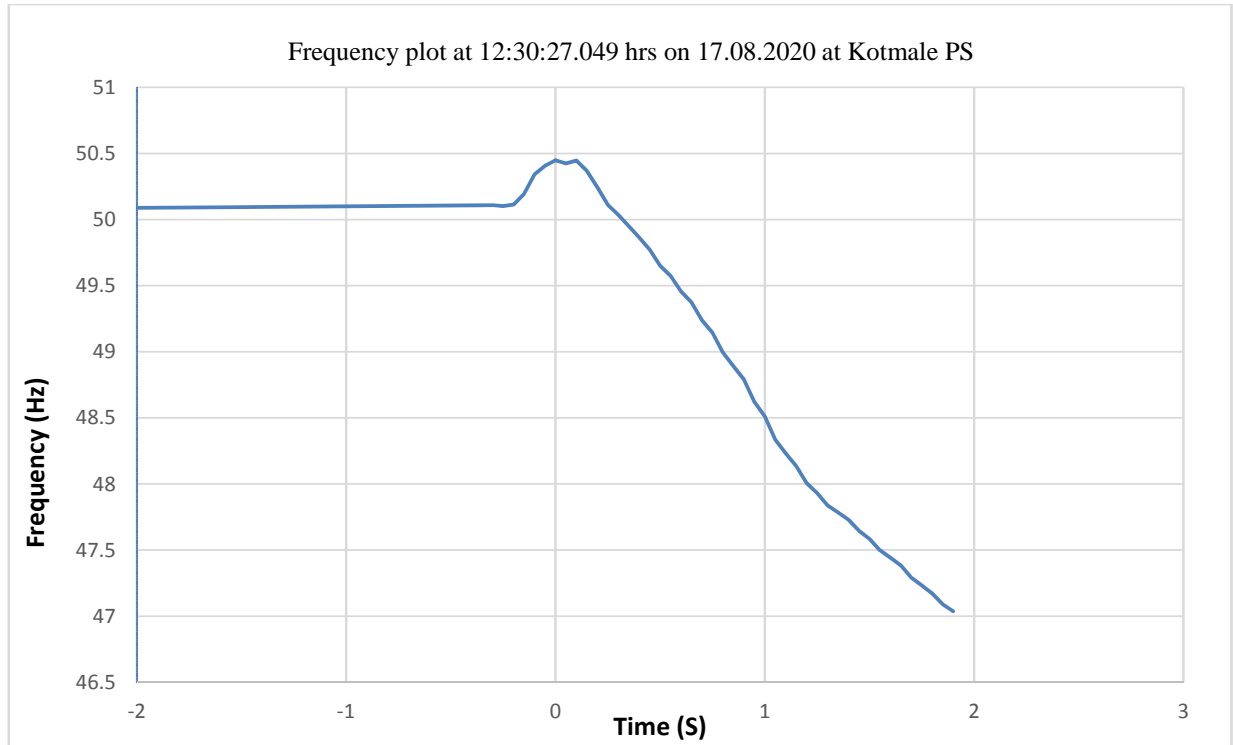


Figure 09: Frequency Variation during the system failure

The sequence of incidents that took place during the system failure is summarized below.

- (1) Busbar protection at Kerawalapitiya 220kV GIS operated and tripped all connected Transmission Lines and Transformers by at 12:30:27.172 Hrs (Figure 1), due to a busbar fault caused by an inadvertent operation of isolator of the buscoupler while the earth switch is closed.
- (2) 220kV Circuit breaker of Generator Transformer 3 at Lakvijaya Power station tripped at 12:30:27.359 Hrs
- (3) 220kV Circuit breaker of Generator Transformer 2 at Lakvijaya Power station tripped at 12.30.27.390 Hrs
- (4) 220kV Circuit breaker of Generator Transformer 1 at Lakvijaya Power station tripped at 12.30.27.429 Hrs
- (5) Phase B to Ground fault of approximately 8.5 kA occurred in 220kV Bus section 1/3 at 12:30:27.423 Hrs and all lines and Transformers connected to Bus Section 1 and Bus section 3 tripped due to operation of busbar protection by 12:30:27.491 Hrs
- (6) As per the DDR of Kotmale PS, the system frequency dropped below 47 Hz within 1.9s from the initial Busbar Protection fault at Kerawalapitiya Grid Substation resulting total system failure.

Tripping times of Generator Transformers of Lakvijaya Power Station are marked on the frequency plot below,

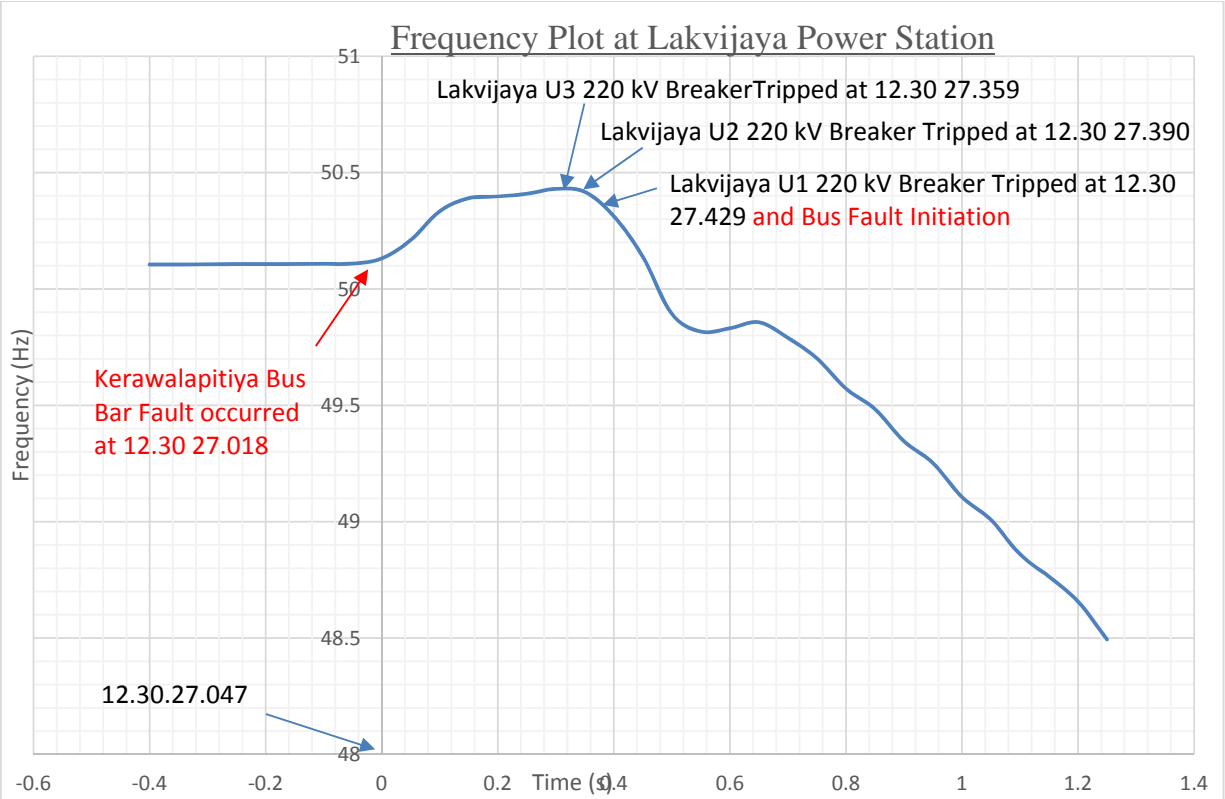


Figure 10: Frequency Variation at Lakvijaya Power Station during the system failure

It is observed that Busbar fault occurred at Kerawalapitiya Grid Substation was cleared within 154ms with the tripping of all connected circuit breakers by the operation of Busbar differential protection. The SIEMENS 7SS522 Busbar protection system has issued the trip command within 87ms. However as per the relay manual, tripping command should be issued within 65ms.

Generator Transformers 3, 2 and 1 of Lakvijaya Power Station has tripped in 180ms, 210ms and 246ms respectively after the Kerawalapitiya Busbar fault has been cleared. Simultaneously Phase B - N fault has occurred in Bus Section 1/3 resulting in the operation of Busbar protection in both Bus 1 and Bus 3. The Busbar fault was cleared within 61ms. However, Bus 2 remained stable until the system collapsed.

6. CONCLUSION AND RECOMMENDATIONS

Transmission protection has operated correctly isolating the fault from the system within an acceptable time.



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Protection Development Section