Improvement of Reliability and Efficiency of the Power System in NDPL (North Delhi Power Limited) FROM operation and Protection point of view

BY NILESH KANE

Power System Details of the NDPL

NDPL is joint venture company of Delhi Government and TATA Power and looking after Power Distribution of North and North-west area of Delhi.

1. Area of the Distribution- 510 sq.kms.
2. No. of Consumers- 850000
3. Peak Load- 1050 MW
4. Total 66/33 KV Grids- 52
5. 66 KV Lines- 175 KM
6. 33 KV Lines- 156 KM
7. AT&C Losses- 25.83%

Modernization of Power System Protection in NDPL

NDPL has replaced All electromechanical Protection Relays on 66/33/11 KV by Numerical relays (IED) under Substation Automation and Switchgear Replacement cum System Modernization Project in 36 no's 66/33 KV Grid Stations.

16 New Grid Stations Commissioned in NDPL Regime were Automated one with Numerical relays and operated in unmanned mode from Remote since Commissioning.

Grid Station Details in NDPL

No.	Grid Station (MFG)	No. of Grids	Relays used
1	ABB	12	REF542+,543, REL511,REX521
2	AREVA	20	Micom P122/632 Argus relay-1,2
3	SCHNEIDER	4	Sepam Relay-20,40,80 Sepam 2000
4	HONEYWELL	16	Argus, Duo bias, SR745,F650-GE

Improvement in System Reliability

Reliability of the Power System is improved due to following Advantages of the Numerical Relays used as IED.

1.Faster relay operating time as low as 20 ms

2.Effectiveness and Relay Co-ordination is possible on micro level by utilizing multiple elements in the Relay.

e.g. Almost all feeders provided with High-set and IDMT Protection. As At feed end (DTL) only IDMT Protection is available best co-ordination has been achieved by using DT-High set protection at our end.

3.Protection,Metering,Monitoring,Diagnosis

Improvement in System Reliability

and Control functions can be performed from the one unit- IED

4.Various Logics like LBB, Reverse Blocking, Trip Supervision etc. has been configured in the Numerical Relay cum Device.

5.All these Protection relays cum BCU's are well protected with Password. Separate Passwords for operation and Protection facilitate safe Protection settings and eliminated tampering of the relay settings.

6.Ultimate Goal of the Automation is to operate the system in Unmanned mode. Mimic diagrams and friendly relay functions of the Relay helps breakdown team to visualize and understand the fault and operation.

Improvement in System Reliability

Additional Trip Supervision relay and wiring has been reduced by using status inputs of the Numerical Relay.

Following Logics has been Configured in the relay for having effective control and Protection of the system without conventional hard wiring.

1.CBFP cum LBB Scheme.

2.Reverse Blocking Scheme for Bus bar Protection or having coordinated tripping.

e.g. Reverse Blocking scheme is very useful for having co-ordination in tripping between

Improvement in System Reliability

11 KV OG Feeder and 11 KV Incomer Breaker of the Bus. All outgoing feeders send a blocking command for 50 ms to prevent tripping of the Incomer breaker during heavy faults and even in cases of delayed tripping of outgoing feeder breaker.

Control wiring has been reduced by around

30% due to Following

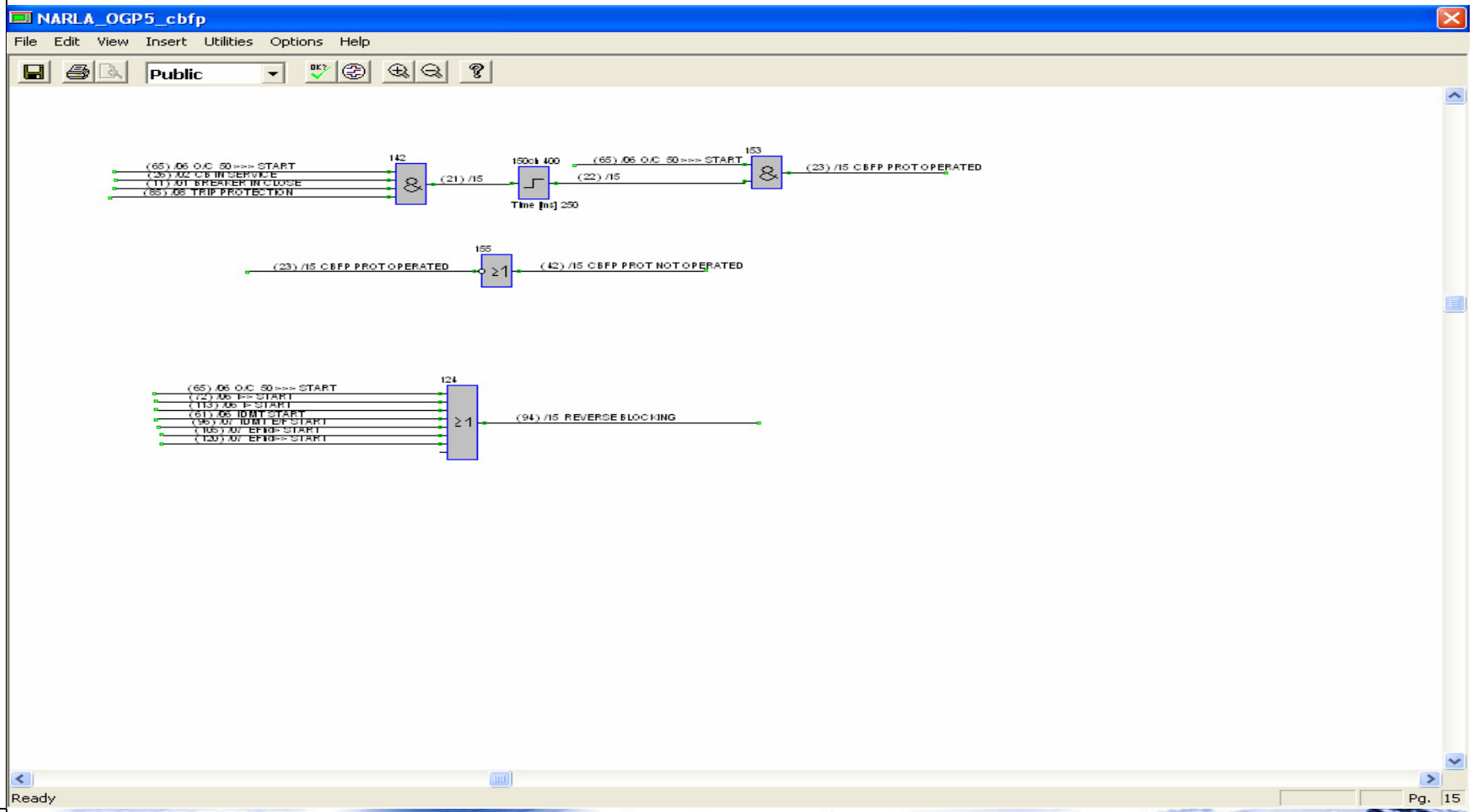
1. Facility of control logic development in the relay.
2. No requirement of interposing CT's and VT's in the system for relay operation. Ratio Correction facility will serve the purpose.
3. No requirement of the Annunciation facia due to availability of sufficient Configurable LED's on relay itself.





North Delhi Power Limited

`CBFP Protection Circuit



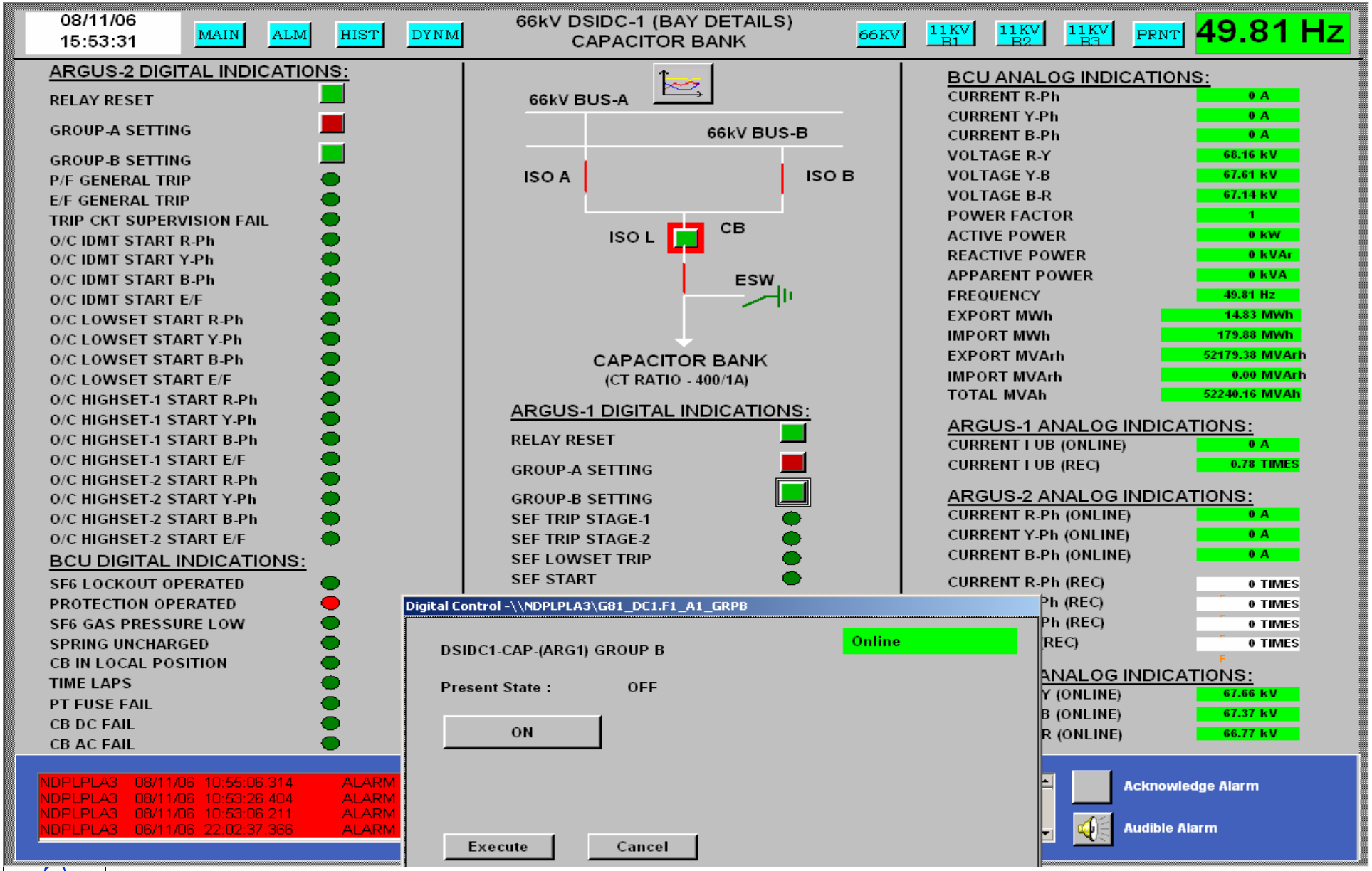
Improvement in System Operation

- Multiple relay setting Groups in Numerical Relay can be utilized for Faster Power Restoration in Emergencies.
- Relay feature of TRI Directional Mode has been used Successfully for Lines fed from Both ends.

Power is being fed to particular area through standard Power flow Diagram. But During Emergencies like failure of Grid or Tripping of EHV Network, Back feeding through the Network is becomes necessary for the Power system Control Department.

Adopted relay settings for standard Power flow will not be suitable for emergency load management and power flow arrangement.

During this type of Situations, second relay setting Group with suitable relay settings can be used.


08/11/06
15:53:31
MAIN
ALM
HIST
DYNM
66kV DSIDC-1 (BAY DETAILS)
CAPACITOR BANK
66KV
11KV B1
11KV B2
11KV B3
PRNT
49.81 Hz
ARGUS-2 DIGITAL INDICATIONS:
RELAY RESET
GROUP-A SETTING
GROUP-B SETTING
P/F GENERAL TRIP
E/F GENERAL TRIP
TRIP CKT SUPERVISION FAIL
O/C IDMT START R-Ph
O/C IDMT START Y-Ph
O/C IDMT START B-Ph
O/C IDMT START E/F
O/C LOWSET START R-Ph
O/C LOWSET START Y-Ph
O/C LOWSET START B-Ph
O/C LOWSET START E/F
O/C HIGHSET-1 START R-Ph
O/C HIGHSET-1 START Y-Ph
O/C HIGHSET-1 START B-Ph
O/C HIGHSET-1 START E/F
O/C HIGHSET-2 START R-Ph
O/C HIGHSET-2 START Y-Ph
O/C HIGHSET-2 START B-Ph
O/C HIGHSET-2 START E/F
BCU DIGITAL INDICATIONS:
SF6 LOCKOUT OPERATED
PROTECTION OPERATED
SF6 GAS PRESSURE LOW
SPRING UNCHARGED
CB IN LOCAL POSITION
TIME LAPS
PT FUSE FAIL
CB DC FAIL
CB AC FAIL
66kV BUS-A
66kV BUS-B
ISO A
ISO B
ISO L
CB
ESW
CAPACITOR BANK
(CT RATIO - 400/1A)
ARGUS-1 DIGITAL INDICATIONS:
RELAY RESET
GROUP-A SETTING
GROUP-B SETTING
SEF TRIP STAGE-1
SEF TRIP STAGE-2
SEF LOWSET TRIP
SEF START
BCU ANALOG INDICATIONS:
CURRENT R-Ph 0 A
CURRENT Y-Ph 0 A
CURRENT B-Ph 0 A
VOLTAGE R-Y 68.16 kV
VOLTAGE Y-B 67.61 kV
VOLTAGE B-R 67.14 kV
POWER FACTOR 1
ACTIVE POWER 0 kW
REACTIVE POWER 0 kVAr
APPARENT POWER 0 kVA
FREQUENCY 49.81 Hz
EXPORT MWh 14.83 MWh
IMPORT MWh 179.88 MWh
EXPORT MVArh 52179.38 MVArh
IMPORT MVArh 0.00 MVArh
TOTAL MVAh 52240.16 MVAh
ARGUS-1 ANALOG INDICATIONS:
CURRENT I UB (ONLINE) 0 A
CURRENT I UB (REC) 0.78 TIMES
ARGUS-2 ANALOG INDICATIONS:
CURRENT R-Ph (ONLINE) 0 A
CURRENT Y-Ph (ONLINE) 0 A
CURRENT B-Ph (ONLINE) 0 A
CURRENT R-Ph (REC) 0 TIMES
Ph (REC) 0 TIMES
Ph (REC) 0 TIMES
REC) 0 TIMES
ANALOG INDICATIONS:
Y (ONLINE) 67.66 kV
B (ONLINE) 67.37 kV
R (ONLINE) 66.77 kV
Digital Control -\\NDPLPLA3\G81_DC1.F1_A1_GRPB
Online
DSIDC1-CAP-(ARG1) GROUP B
Present State : OFF
ON
Execute
Cancel
NDPLPLA3 08/11/06 10:55:06.314 ALARM
NDPLPLA3 08/11/06 10:53:26.404 ALARM
NDPLPLA3 08/11/06 10:53:06.211 ALARM
NDPLPLA3 06/11/06 22:02:37.366 ALARM
Acknowledge Alarm
Audible Alarm

Improvement in System Operation

Earlier this changeover takes time due to manual Intervention and clearance from Protection Department.

Due to Station Automation, Group Changing can be done from Remote HMI and Power restoration through Other Network is Faster with Suitable Relay Settings.

Various functions like Broken conductor are very useful for isolation of fault for unloaded feeders.

e.g. Conductor snapping fault on unloaded or less loaded feeders couldn't be sensed earlier. Broken conductor features with negative phase seq. principle traces the fault immediately.

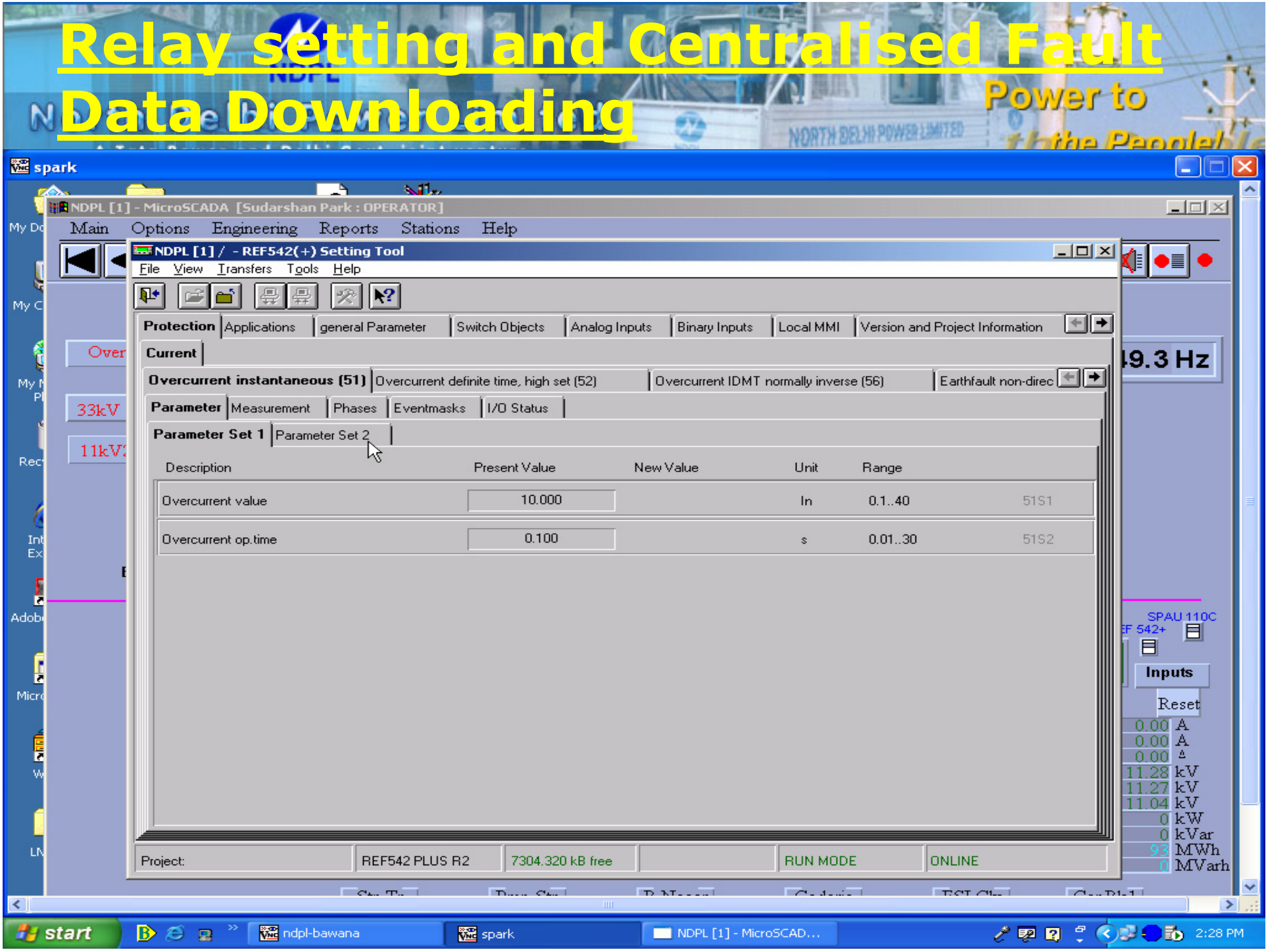
Relay setting and Centralised Fault Data Downloading

Relay settings and FDR Downloading for various tripping was difficult one because data downloading was done from individual sites and relays.

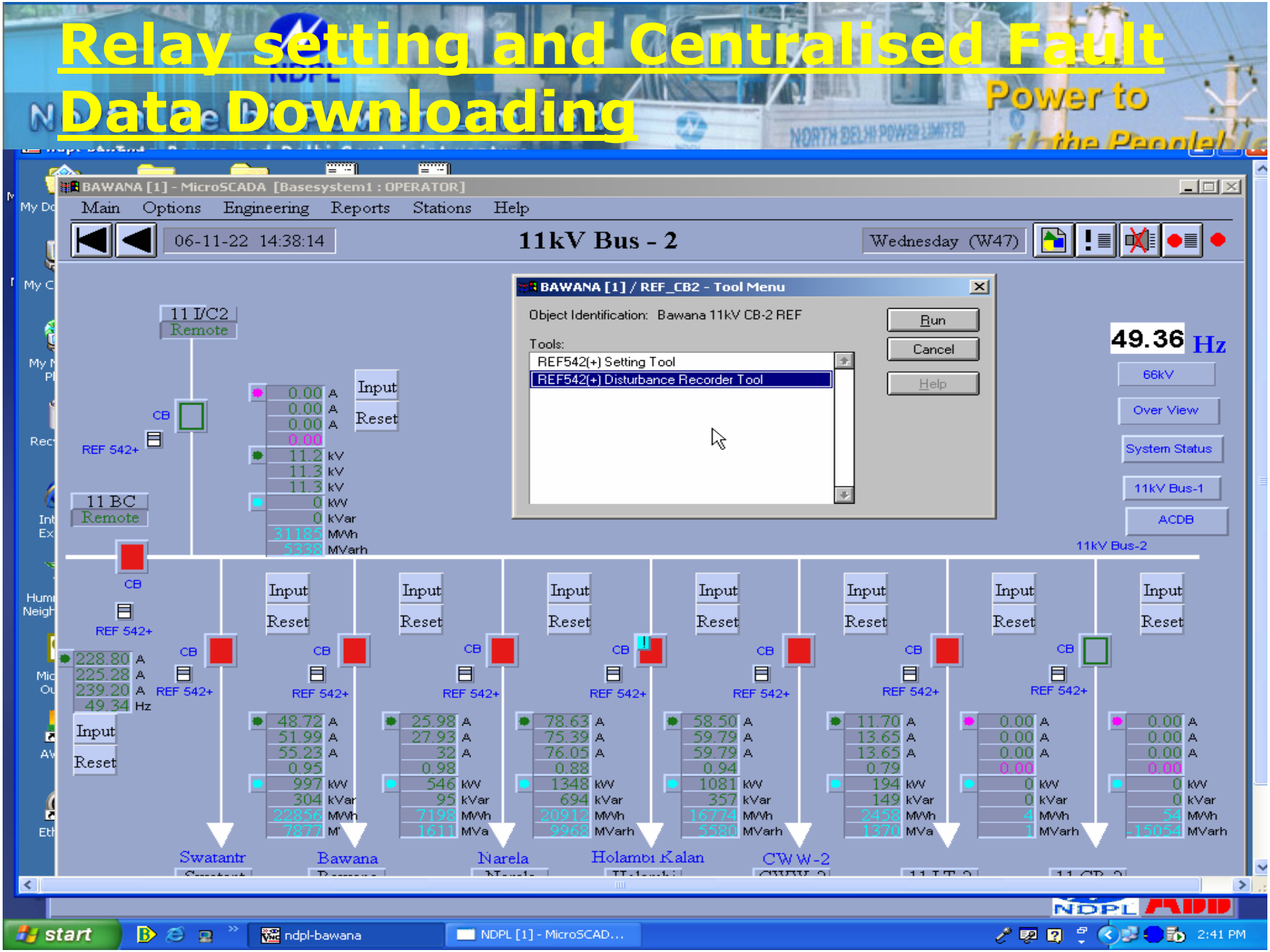
Job become easy with Online Relay setting and FDR (fault data records) Downloading is possible after implementation of Grid automation project through Centralized Power system control station.

Faster Tripping Diagnosis makes the faster restoration of the system as well immediate corrective actions.

Relay setting and Centralised Fault Data Downloading



Relay setting and Centralised Fault Data Downloading



Improvement in System Operation

Auto recloser function can be very useful for overhead lines for restoration in the event of the transient fault.

Scheme has proved to be successful on 66 KV side. same feature is under consideration for implementation on 11 KV side with available breaker and Numerical relays in overhead Network for early restoration.

Numerical Relay are self Protected one and relay failure (IRF) is immediately communicated to Remote HMI. Backup current operated relays are also useful and interlocked during failure of relay or during DC Failure.

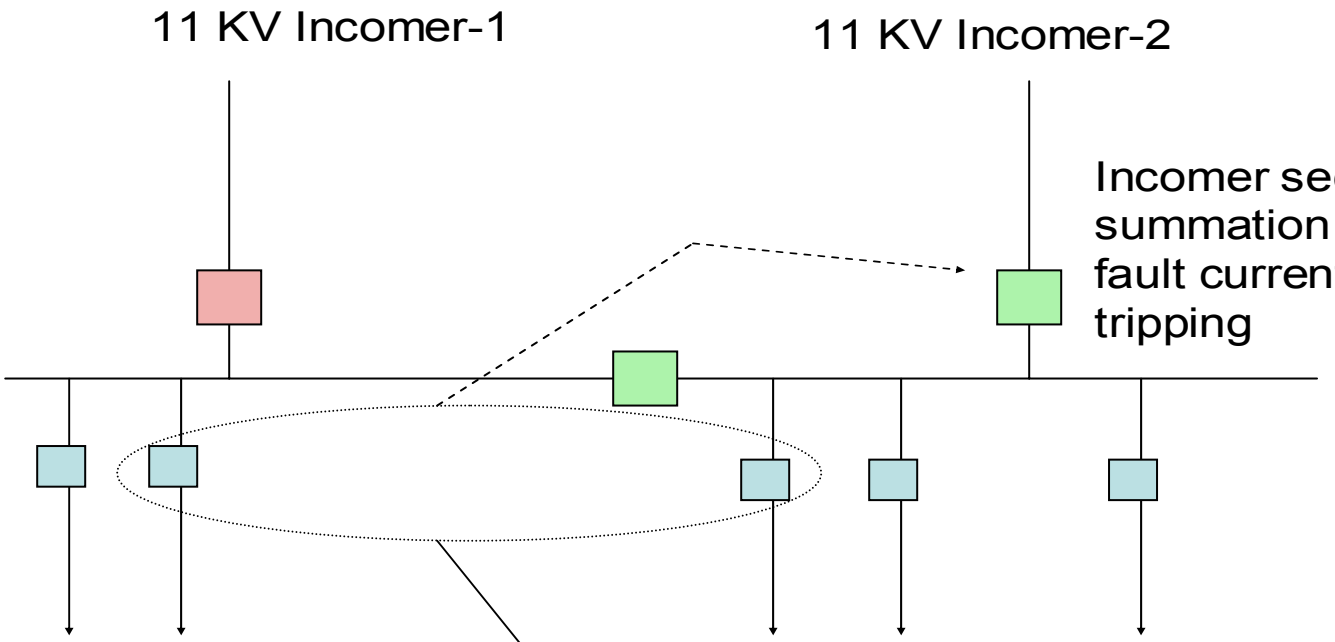
Improvement in System Due to exact Diagnosis of the Fault.

Repeated trippings due to unavailability of the necessary data and co-relation of the sequence of events are totally reduced due to time synchronisation of the all IED's and availability of the various diagnosis Tools like event list, Waveforms etc.

Performance of the System is also improved due to Substation automation by correct and timely corrective and preventive actions due to availability of the exact and correct behaviour data of the tripping events.

Case Study of the Critical Analysis.

11 KV Incomer tripping alongwith 11 KV Outgoing Due to fault summation at RG-22 Grid.



Case Study

Tripping Analysis report for 11 KV Mithila Vihar feeder alongwith 11 KV Incomer.

Details of event:

11 KV Mithila Vihar feeder tripped alongwith 11 KV Incomer

Observations:

Total load of the station is around 800 Amps and System is keeping total load on any of the transformer keeping the other transformer on no load.

Mithila Vihar feeder tripped on over current High set.

11 KV Incomer-2 tripped on over current High set.

Fault data record of the Incomer show's that Fault seen by 11 KV Incomer is 9.1 KA while fault seen by Mithila Vihar feeder is 6.2 KA.

It is observed that Nithari feeder was also seen the fault but not tripped due to isolation of the fault. Protection settings were coordinated and CT Ratio adoption was found correct.

Conclusion:

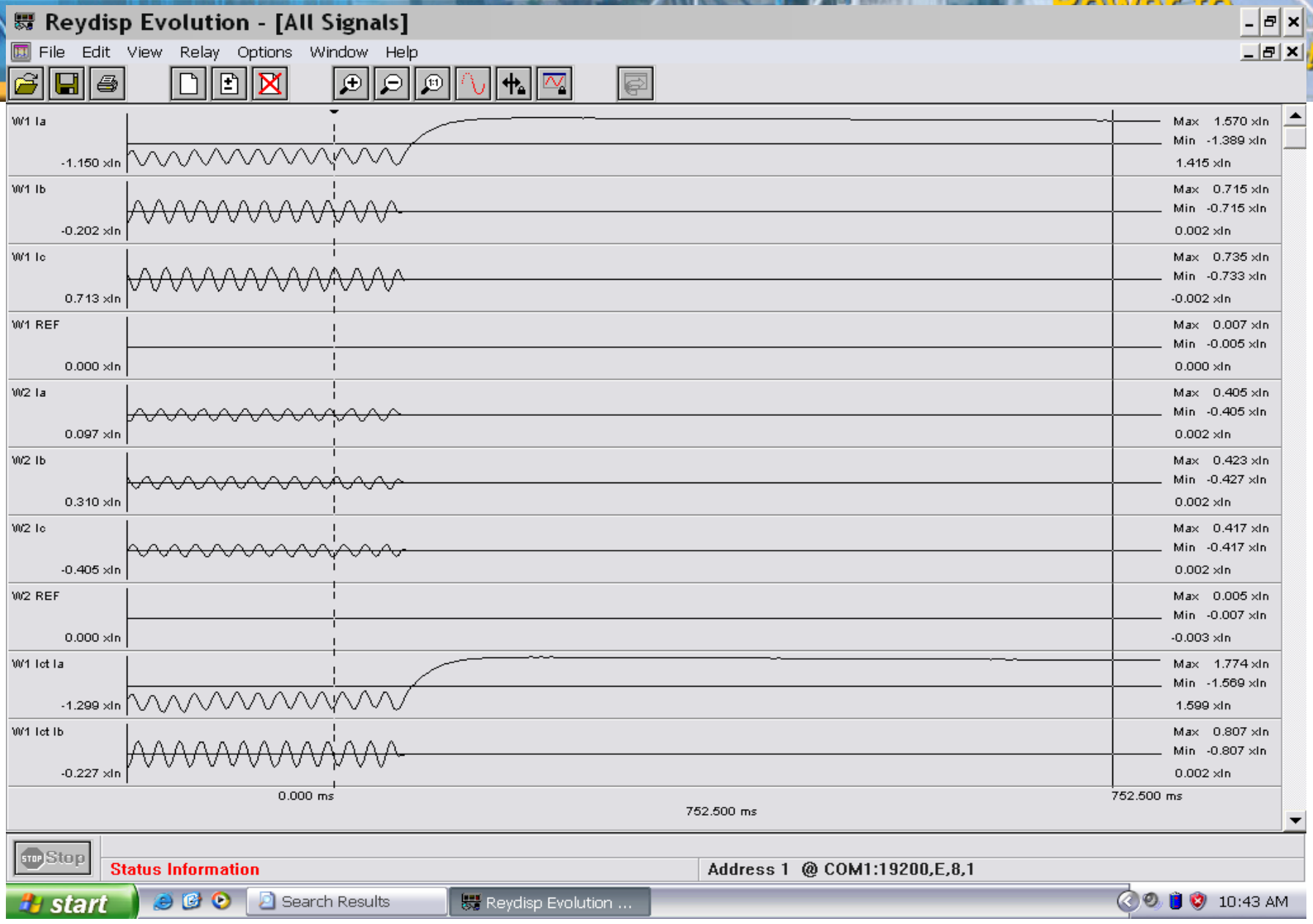
After going through the tripping events it was observed that both feeders were getting tripped simultaneously.

After going through the fault data record, it is very clear that fault seen by Incomer is always on higher side as compared to the outgoing feeder.

The tripping in the incomer occurs as the fault current "seen" by the incomer breaker is a summation of the outgoing faults.

It has been learnt from Concerned Zonal staff, that both the outgoing feeders in question, viz. Mithila Vihar feeder and Nithari feeder, are routed on the same poles and on same cross arm. Thereby, the occurrences of birdages in both the feeders occur simultaneously.

Case Study of the Critical Analysis.



Case Study

Event: TR-2 tripped on differential protection at in Badli Grid.

Observations:

It was observed from the waveforms of the tripping event that stray DC Current component was present in R Phase current at the time of event.

It was also confirmed from the event that DC Ingress has caused the tripping.

(Please refer to snapshot of disturbance in badli ,attached).

Total circuit wiring was checked including external CT Circuit to find out the source of DC Ingress in the Relay, It was confirmed that no ingress was there through external cabling.

Even after isolating external circuit, Relay has generated tripping.

Waveform of this particular event was showing that tripping is purely due to DC Component of the current in CT Circuit. It also shows that after Decay of the DC Current Output relay got resetted.

Case Study

Conclusion:

1. It is confirmed that Tripping is due to intermittent DC Ingress in R Phase Secondary of HV CT Circuit especially.
2. In modular type Duo-bias relay, two separate modules are there for power supply as Well as CT Circuit. It seems DC is getting mixed up in CT Circuit within the relay.

Corrective Action: Relay was got repaired for failure of the Isolation between two modules. AS well Possible CT Saturation due to DC Ingress in CT Secondary was prevented

USE OF TMU FOR POWER TRANSFORMER

USE of Transformer Monitoring Units as IED in system has made the Transformer functionality more accurate and redundant one.

Parallel operation, OLTC Control, Fan control, Voltage regulation, Oil and Winding temperature based on load and Transformer life analysis could be achieved with compact control cubicles for Power Transformer.

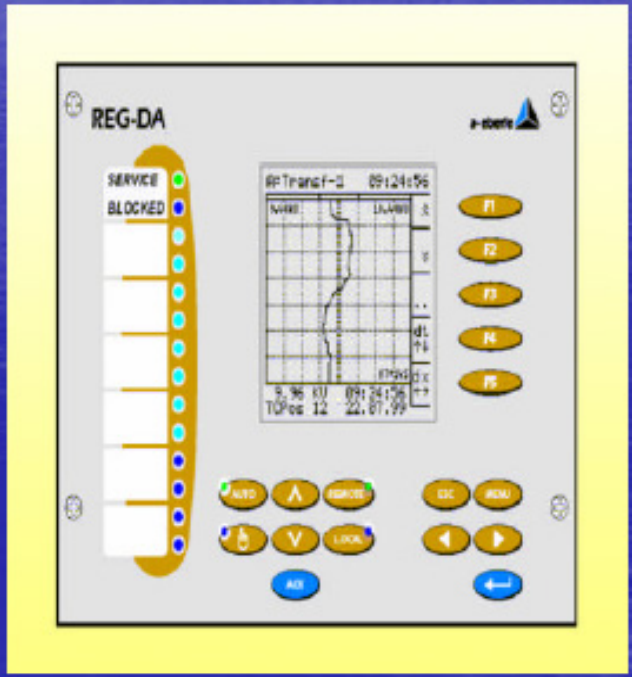
RTCC Panels and Its wiring has been removed due to installation of these compact device.

Alarm and Trip generation, alongwith event data and Graphical trends of the various transformer Parameters can be achieved due to use of TMU

USE OF TMU FOR POWER TRANSFORMER

REGSys™ in Recorder mode

- Display of
  - Prevailing Voltage
  - Tap changer position
  - Admissible regulative deviation
  - Graphical presentation of Voltage, Voltage & Current with respect to time
- Values are measured every 100ms and can be presented for every 1 second
- Values are stored for average 1 month time



FEATURES OF TMU

Following features of the TMU are Helpful in Monitoring the operation of the Transformer

1. Voltage control/Regulation through various compensation/control
2. High speed Forward Backward Switching of OLTC for Voltage control
3. Fan control through temperature settings.
4. Display of Voltage/Current/Power/Power factor etc and can be used as Output also for remote indication.
5. Event log of the selected functions.
6. Recorder mode monitoring of OTI/WTI/VOLTAGE CURRENT in Dual Parameters at a Time.
7. Correct calculation based on Algorithm for WTI with input of OTI/LOAD OF Transformer/Winding exponent/Time constant of winding

IMPROVEMENT IN PPI

(Performance Index of the Protection Department)

Performance of the Protection Department is measured in Terms of the Performance index calculated in terms of no. of Un-coordinated trippings in the Network.

PPI=CORRECT TRIPPINGS/TOTAL TRIPPINGS

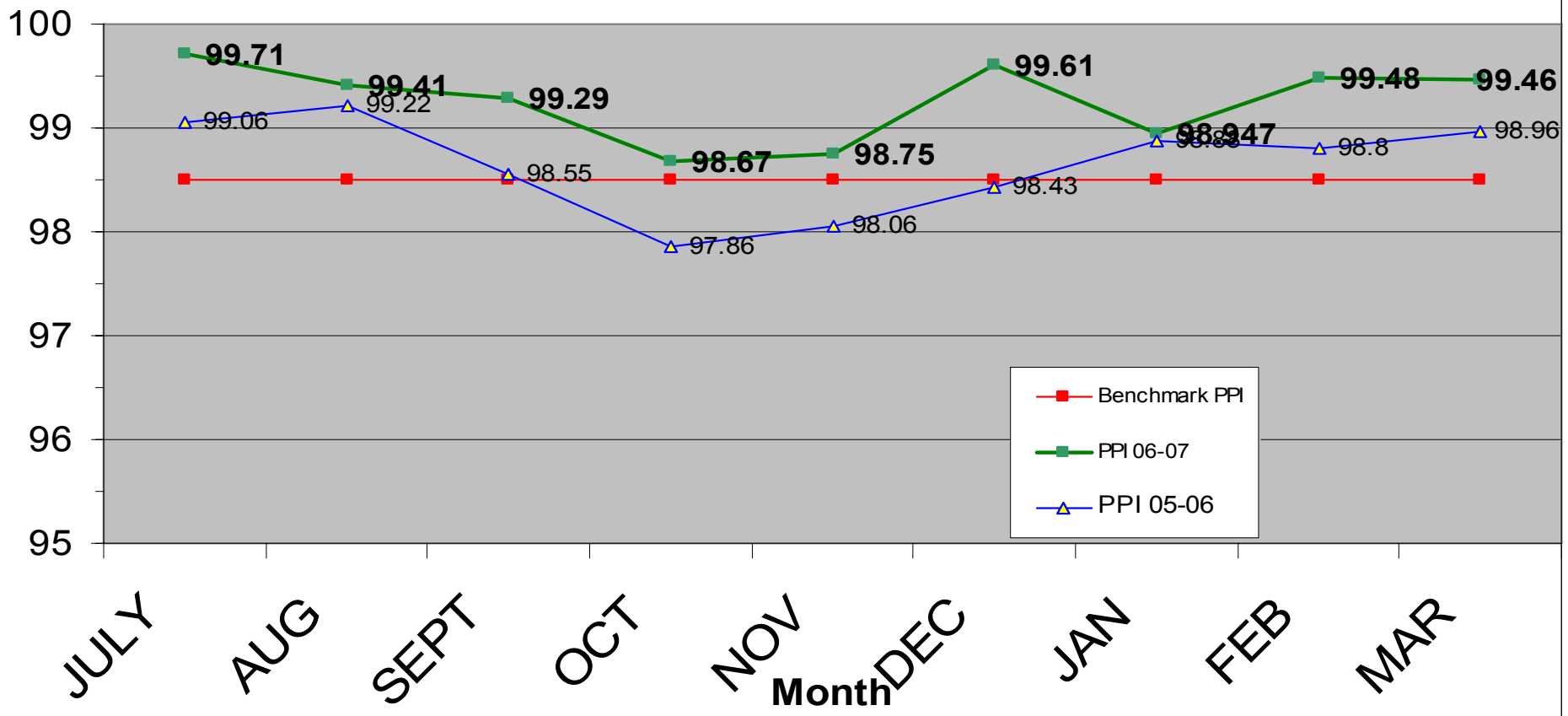
After Implementation of the Sub station Automation and commissioning of the Numerical relays in 66/33/11 KV Network, no. of incorrect trippings has been reduced due to immediate Corrective and Preventive Action.

AVARAGE PPI HAS BEEN INCREASED FROM 98.55 TO 99.31% DUE TO EFECTIVE CAPA DONE FOR VARIOUS TRIPPINGS

Comparative Chart Shows the improvement in PPI after Commissioning of the Station Automation in NDPL.

IMPROVENT IN PROTECTION PERFORMANCE INDEX

Protection Performance Index-Comparison 2005-06 & 2006-07



SUMMARY

Following benefits and improvement in the System in terms o the Reliability and Performance has been achieved.

1. **Faster operation of the system with correct indication. Improvement of the system with faster Corrective and Preventive Actions.**
2. **Efficient and Correct Fault Discrimination. Increased trend of performance index from incorrect tripping point of view. "Without indication" Tripping phenomena has nullified in modern Automated system.**

SUMMARY

3. Record of Real time metering alongwith its quality features like THD are available.
4. Online Diagnosis and relay setting for various Power flow patterns.
5. Self protected devices with due indication on remote HMI for immediate corrective action.
6. Effective Load management with availability of the Trends of various parameters and generation of the energy reports with Graphical presentation.
7. Various operator friendly features of the Automation are helpful for safe and faster operations.

e.g. Safety tagging facility.


NDPL
North Delhi Power Limited
A Tata Power and Delhi Govt. joint venture
NORTH DELHI POWER LIMITED
Power to
the People

THANKS