Study Committee B5

Protection and Automation

10472_2022

Improvement in Asset Management of EHV Substations through remote operations – Case Studies.

R.K. ARORA, PRADEEP KUMAR GUPTA, NITIN SINGH, B. VEER RAJU

Power Grid Corporation of India Limited

Background & Motivation

- Large quantum of data from different substations are reporting which needs to be analysed by the operators for taking up corrective and preventive action on transmission assets. Manually identifying critical event by operator is a tough task.
- To minimise risk, extend assets life and improve performance & reliability.
- Understanding real-time situational awareness during multiple events.
- To identify critical event information and defective equipment for timely rectification

Subsystems & dashboards created

- Supervisory Control and Data Acquisition System (SCADA) is the main system for remote operation of EHV switchgear and monitoring of substation assets.
- SCADA system is enriched with the following subsystems & dashboards to enable the operator to identify critical information and defective equipment for timely rectification.
- To enable the operator to identify critical information

Intelligent Alarm Dashboard	CT, CVT Dashboard	PMU data
The events and alarms existing in SCADA are logically categorised in different groups and segregated region wise	The real time health of CT & CVT are monitored by observing deviations in their analog values	In addition to WAMS application, PMU data is used for identification of fault and its analysis. Disturbance analysis involving multiple elements
Remote Accessibility System	**Automated Fault Analysis System**	**Visual Monitoring System**
Collects DR automatically from Relays across all substations	The collected DR files are used in Automated Fault Analysis System (AFAS) for automated fault analysis and sending alerts to concerned team	Cameras are installed in all substations in order to ensure safe operation and monitoring of activities

Intelligent solutions implemented for substation integration for remote operation

- Bay Control Unit (BCU) are used for performing control commands on switchgear and logics for synchronization & operational interlocks.
- Complete station is covered by surveillance cameras under Visual Monitoring System (VMS). Intrusion detection system is being enabled in VMS for any movements in substations and alarms are raised at control center, if detected any.
- Automatic DR collection from IEDs.
- Online Dissolved Gas Analysis (DGA) devices for transformers & reactors and Controlled Switching Device (CSD) for CB are installed to monitor healthiness and indexing the equipment.
- Automatic control of outdoor lighting system by photo sensors and logic controllers.
- Level switches are installed for monitoring water & fuel level in firefighting system & Generator.
- Sensors are used to detect indoor and outdoor temperature, humidity at substations.

Case studies

- ICT turret CT cable core damage identification.
- Faulty CVT & CT identification.
- Identification of Circuit Breaker having defects in operating Mechanism and contacts.
- Defective isolator identification before developing major breakdown/fault.
- Gas Insulated Substations leakage identification.
- Utilization PMU and SCADA data to assist judicious and prompt action on incident.
- Around 70-80 critical abnormalities are identified and rectified annually.

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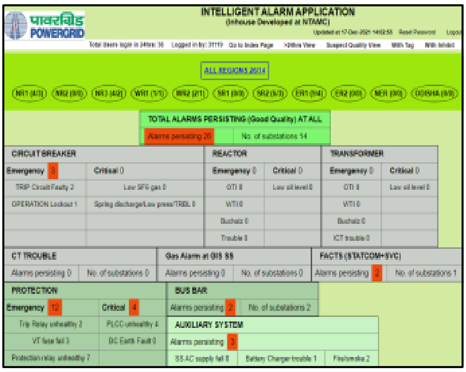
Intelligent Alarm Dashboard

- Alarms categorization with 'equipment and signal type' is being done after satisfying certain criteria like persistent for defined time interval and excluding alarms due to planned outages.



CT Dashboard

- An application has been developed to identify predefined drift in current between phases.
- Monitoring on very short intervals for defects.
- Based on the quantum of drift, CT's are indexed for checking, testing and maintenance priority.
- The logic is developed based on condition that deviation in bays current between phases is primarily because of high resistance path due to loose contact/connector.
- the deviation in each phase current w.r.t average current of all the three phases

Bay	IR	IY	IB	Dev(%) R	Dev(%) Y	Dev(%) B
204	13	4	115	70	91	
411	122	138	21			78

CVT Dashboard

- Lot of time is required to measure the secondary voltages of all line elements of substation.
- Reason of drift may also be due to time lag between measurement of reference CVT and CVT on which voltage is being measured.3
- Possibility of deviation in secondary voltage exists between predefined frequency of monitoring.
- Above challenges have been overcome by monitoring the drift in CVT secondary voltages based on the real time voltages reporting in SCADA.

Sl. No.	Drift in secondary Voltage (X) volts	Condition	Measurement Frequency
1	Upto ± 0.5	Healthy	06 monthly
2	+ 0.5 to +0.8	To be monitored	03 monthly
3	+0.8 to +1.2	Close monitoring	Monthly
4	+1.2 to +1.5	Close monitoring	15 days
5	Above +1.5	Alarming	Replacement
6	-0.8 to -4.0	Close monitoring	15 days
7	Less than -4.0	Alarming	Replacement

PMU data

- For historical trends of analog parameters of lines
- For fault and disturbance analysis
- For CVT healthiness monitoring
- Disturbance monitoring through regional trends

Remote Accessibility System-RAS

- DR files are automatically collected in web application which can be access by operators instantly after the fault from any relay in any substation.
- RAS system also gives the status of relay communications to remote control center.

Automated Fault Analysis System-AFAS

- Acquires data from RAS server and analyses the Fault.
- Generated automated fault analysis report readily available to operator.
- Report is readily shared through email & SMS.
- Double end fault report is generated in AFAS which takes the disturbance recorders from both ends and accurately analyses the fault

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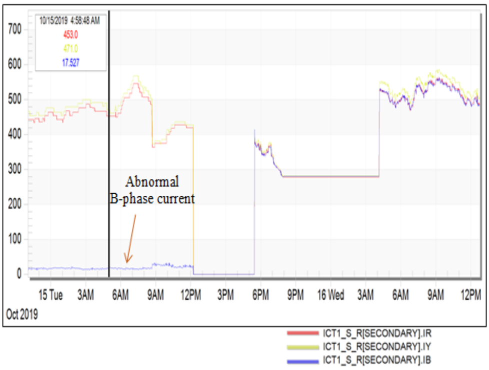
Case: 765/400kV ICT-I, B-phase Turret CT core defect.

- Current imbalance was noticed in “B” Phase of secondary side. As, R = 453A ; Y = 471A ; ***B =17A***
- At Site initial checks were carried and found that the insulation of Turret CT cable is damaged with one strand of multi-strand wire was intact.
- Damaged wire was replaced with spare and the currents became normal.



Case: GIS- SF6 gas leakage from UHF sensor.

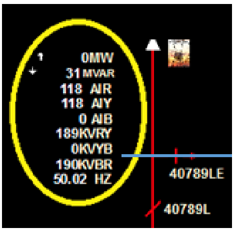
- Alarm dashboard has detected the gas leakage alarm in 400kV line compartment and rectified the same.

Case: Isolator current zero (R-phase) & hot spot.

- Discrepancy was observed in the R-phase current in 714 tie bay at control center as below:
- Tie bay Currents: I (R) = 0A; I (Y) = 78A; I (B) = 68A.
- Pitting and hotspot found in terminal connector of future bay isolator (71389A) which is towards Bus-1.
- Terminal pad was found damaged due to hotspot, replaced the same with spare.

Case: CB Faulty CVT & CT identification. pole stuck

- Pitting and hotspot found in terminal connector of future bay isolator (71389A) which is towards Bus-1.
- Terminal pad was found damaged due to hotspot, replaced the same with spare.



Conclusion

- This paper has discussed the challenges for operator to have an eagle eye on all the substations from single point sitting at a control room and handling high volume of data and events. The paper has emphasized the importance of application tools mitigating challenges posed to operator to a great extent. These developments will help real time system operator to take crucial decisions in asset management based on data.