Department of Electrical Engineering

Workshop Report

“Sub-Station Functioning & Protection”

By

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ACKNOWLEDGEMENT

We express our feeling of gratitude to Mr. Ashish Pipariya, Deputy Engineer, GETCO, 220 KV Substation, Vartej, Bhavnagar for the seminar conducted based on Substation functioning and protection and followed by the site visit at 220 KV substation for actual field equipment understanding. We highly appreciate for his very informative presentation and explanation. We are also very much thankful to the executive engineer Mr. Upadhyay for granting permission to visit 220 KV sub-station.

We are very much thankful to Dr. H. M. Nimbark, Principal, GMIT for allowing and guiding for the proper execution of the workshop. We are also very much thankful to the management of GMIT for allowing and providing required infrastructure.
GENERAL INFORMATION

A workshop was organized for the students of 4th semester electrical engineering. The workshop was carried out in two phases. During first phase, on 28th February, 2017, a seminar and power point presentation was arranged regarding Sub-station functioning and protection. During second phase, on 7th March, 2017, site visit to the 220 KV sub-station was arranged.

Mr. Ashish Pipariya, Deputy Engineer, GETCO was the expert available for both the phase of workshop to explain and guide the students. He is very experienced and having diversified knowledge regarding operation, maintenance and testing of sub-station equipments.

During first phase, the seminar was divided into two sessions. In the first session, all the details regarding major equipments of the substation, especially, power transformer, its functioning, all the required protections, maintenance were discussed. Different types of sub-stations, indoor and outdoor type and Gas Insulated (GIS), generation, transmission and distribution system were explained in detail.

In the second session, conditioning monitoring, different tests and circuit breaker operation were emphasized. At last the session was concluded with question answer session and all the queries generated were satisfied.

The seminar was highly informative. A brief introduction and words of gratitude were offered by Prof. Anish Vora, Head- Electrical Engineering Department.

During second phase all the participants visited the 220 KV sub-station and had the opportunity to observe all the equipment functioning along with control room, different protective systems, battery charging center and PLCC center.
OBJECTIVE

Large and high voltage transmission lines are necessary to transmit huge blocks of power from the source of generation to load centers. Sub-station is integral part of the power system.

The main objective of the workshop was to understand the functioning of sub-station, major equipments of the sub-station and protection.

To understand the protection of power transformer, operation of various circuit breakers, correct sequence of operation, fault condition, different types of protective and control relays, function of CT and PT for instrumentation and protection function.

To understand consistent, reliable and quality power as well as restoration of power in minimum time after fault condition, precautionary maintenance, routine test, conditioning monitoring, various tests to be carried out, test kits and safety of equipments as well as human.

To understand different standards this must be followed.
ASSIMILATION

Topics covered during seminar

Operation & Maintenance

- **Circuit Breaker**
  - Operation
  - Construction
  - Interrupting principles
  - SF6 gas filling & handling
  - Manufacturing & Testing
  - Inside the Breaker
  - Circuit Breaker Pole Assembly
  - Circuit Breaker Operating Mechanism Assembly
  - Maintenance & troubleshooting

- **Instrument Transformers**
  - Operating principles & Construction
  - Operation
  - Maintenance, troubleshooting & Testing

- **Power Transformers**
  - Introduction, basic about Transformers – Design aspects, insulation
  - Transformer Accessories – Breather, Bushings, PRV, Buchholz, MOLG Core & Active Part Assembly, Final Assembly
  - Operation, commissioning
  - Maintenance and Diagnostics

- **Condition Monitoring**
  - Concept of Condition Monitoring
  - Degradation of Insulation
  - Significance of loss angle measurement & insulation resistance measurement
  - Recovery Voltage Measurement
  - Leakage current monitoring
  - Infra Red Image
  - Contact Resistance Measurement & DCRM
  - Oil Testing Demonstration of various diagnosis tests
Sub-Station

A substation is an integral part of an electrical generation, transmission and distribution system. As per the classification of substation, different types of substation based on their function, like, transformer substation, switching substation, frequency substation, converter substation etc. and based on their location, indoor or outdoor type and gas insulated substation. Most of the substations are transformer substations, hence main equipment is power transformer for step up or step down operation of voltage. All the other equipments installed are for the protection of the transformer, like lightening arrester, circuit breakers, isolators, CT, PT, CVT, Bus bars, insulators etc.

Power Transformer

Power transformers are with HV and LV windings and core. Transformers are oil filled transformers. Dielectric strength of the oil must be high and for that it is preserved from
the environment contact to avoid the slightest content of moisture. For the cooling purpose for high rated transformer, forced cooling is used. Oil pumps are installed to circulate the oil from oil tank to radiators and back, at the same time cooling fans are also operated. In case of fault condition, gas operated Buchholz relay is also installed between oil tank and conservator tank. Breather and function of silica gel is also very important. On line tap changers also play very important role to maintain level of voltage constant.

CT, PT & Protective Relays

Current transformer and potential transformer are very important for instrumentation, measurement as well as protection purpose. After step down operation of current as well as voltage, signals are used for protective relays to be operated during abnormal power condition. Operation of all protective devices is based on correct function of CT and PT.
Circuit Breakers & Operation

Different types of circuit breakers are used like, VCB, OCB, Air Blast etc. Now a day in all modern substations SF6 type circuit breakers are used. Arc generation and arc extinguishing operation are explained. Different main and auxiliary contacts and operation of breakers are also studied. Importance of spring charged and motorized breakers are explained. Necessity of isolator is explained and to discharge the line, earth switches are also used.
 Conditioning Monitoring & Tests for different equipments

Different test, its importance and required tools for conditioning monitoring were discussed. Tan Delta test to determine the insulation degradation for transformer winding, bushing CT, bushing PT, bushings etc was discussed. Thermal imaging for loose contact detection, oil analysis, dissolves gas analysis, conditioning monitoring for CT & CVT were also the point of discussion.
220 KV Substation Site Visit

After completion of seminar a site visit was also organized at 220 KV Vartej sub-station to observe the actual equipments and its functioning at field.

Team of engineers explained each and every equipments in depth. Control room was also visited and control panels were observed. Different types of protective relays and its function, battery charging center etc.

Power distribution with single line diagram was explained. An assessment test was also arranged after completion of visit.
OUTCOME

The goal of the workshop was to improve the ability of students to understand operation and maintenance of substation and to do the analysis of existing equipments with contingency analysis and reliability.

Upon completion of this course, students will be able to

- assess the condition of switchyard equipments
- avoid age related failure
- minimize cost of consequential failure of peripheral equipment
- minimize unavailability of power due to forced shutdown
- optimize resources to plan and operate the electric systems reliably and with the maximum economic benefit