

Report on failure of transformers of Gujarat Energy Transmission Corporation Ltd. (GETCO) at 5 nos. of their high voltage substations.

GETCO reported failure of HV transformers at their following five substations.

- a) Failure of 220/132 kV, 150 MVA Transformer at the 220/132/66 kV Ranasan Substation on 10/12/2006.
- b) Failure of 220/66 kV, 50 MVA Transformer at the 220/66 kV Dhansura Substation on 17/12/2006.
- c) Failure of 220/66 kV, 100 MVA Transformer at the 220/132/66 kV Mehsana Substation on 22/04/2006.
- d) Failure of 132/66 kV, 40 MVA Transformer at the 220/132/66 kV Anjar Substation on 08/03/2007.
- e) Failure of 220/66 kV, 50 MVA Transformer at the 220/66 kV Nakhatrana Substation on 28/03/2006.

A standing committee has been formulated at national level to assess the cause of failure and rate of failure of various substation equipment of 220 kV and above voltage class and to suggest remedial measures so as to minimize / avert such failures in future. As part of such activity, Sh. B. K. Arya, Deputy Director and Sh. Avinash Arora, Deputy Director of SET&D Division of CEA visited the substations at serial nos. (a) & (b) above i.e. Ranasan and Dhansura on 20/02/2007 and 21/02/2007. Sh. Avinash Arora, Deputy Director, Sh. M. S. Satija, Deputy Director & Sh. Dinesh Jain, Sr. Manager of the SETD Division visited the substations at serial nos. (c), (d) to (e) above i.e. Mehsana , Anjar and Nakhatrana from 31/03/2007 to 04/04/2007 to investigate causes of failure.

During the visits, the teams discussed in detail with the operation and maintenance staff at each substation about the sequence of events leading to failure of the transformers. Relevant data in respect of the substations were also collected.

The following Conclusion And Recommendations are hereby made after the investigation.

Conclusion And Recommendations

1. It is observed that a number of important tests are still not being covered under routine maintenance. In addition to other tests being conducted by GETCO like DC resistance, turns ratio, capacitance and tan delta measurement for winding and bushings, magnetizing current, etc., it is recommended to conduct core to ground insulation resistance measurement and determination of Polarization Index (PI) corresponding to 60secs. and 600 secs. Also, Frequency Response Analysis(FRA), Recovery Voltage measurement, Impedance measurement etc. should form part of maintenance activity. The periodicity of the tests is to be decided. Further regular checks must be made for leakage current monitoring for LAs and for finding hot spots with tools like Infra red camera .

- 2. Dual DC Supply** In line with latest practices in S/s design towards reliability, the GETCO authorities should review their old designs and make provision for second DC source with necessary DCDBs to circumvent the possibility of complete DC failure in the event of DC supply fault to any panel. Also, to this effect circuit breakers with two trip coils are required to be provided. Accordingly necessary arrangements for the same is to be made and control schematics updated.
- 3.** All transformer bushings must be tested for tan delta and capacitance values at suitable intervals and adequate provision for spare bushings must be made for replacements. Bushing failure has been seen as a major cause of transformer failures in GETCO. GETCO authorities must accord priority to elimination of this cause .
- 4.** Persistent faults in windings can be effectively checked by DGA analysis and failures averted. Therefore DGA should be conducted at regular intervals since the moisture and oxygen content of the insulation system has a decisive influence on the ageing rate of power transformer. The oxygen should be monitored closely.
- 5.** Partial discharges sometimes occur in transformer at any moment of time due to ingress of moisture, trapped air due to improper oil filling, long time degradation of insulation. Acoustic partial discharge measurement may be done at different locations on four sides of transformer to detect discharge. It is recommended to corroborate the readings with DGA measurement to avoid catastrophic failure.
- 6.** For substations with pipe earthing, possibility may be explored to provide additional pipe earthing by interconnecting existing pipe earthing by adequate horizontal and vertical pipes in the existing substation layout.
- 7.** Switching schemes for GETCO substations need to be reviewed and depending on the criticality of outgoing feeders necessary changes need to be implemented eg. it is observed that at Ranasan on 132 kV side only single bus system is prevailing. This should be converted to double bus / main & Transfer bus with proper bus bar protection.
- 8.** Nitrogen fire extinguishers available today are much better than conventional fire fighting equipment and all transformers exceeding 50 MVA capacity should be retrofitted with the same.
- 9.** It seems that at present no standard maintenance practice is being followed by GETCO. GETCO may follow condition based maintenance practice using modern diagnostic tools to assess health of various substation equipment including transformers instead of following the conventional Time Based Maintenance (TBM) practices. In the process catastrophic failures can be averted, maintenance

cost can be reduced, reliability & availability can be increased and ultimately life of equipment would be extended. Reliable diagnostic tools, suitable for on site measurement with EMI compliance, should be used to minimize human error involved during testing and to provide reliable, error free observations / test results while measurement is done in a charged switchyard. The operation and maintenance staffs are not well equipped with adequate modern Diagnostic tools for assessment of healthiness of substation equipment. It seems that availability of suitable testing equipment for maintenance purpose is the major constraint of the utility.

10. As recommended in an earlier report each testing group should have following major testing tools:

- Automatic Capacitance and tan delta measuring instrument
- Leakage current monitor for surge arrester
- Static contact resistance meter
- Circuit breaker operational analyser and Dynamic Contact Resistance Meter(DCRM)
- Automatic relay test kit suitable for testing electromechanical / static / numerical relays
- Frequency Response Analyser (FRA) test set
- Earth tester for measurement of soil resistivity and ground resistance
- Thermovision camera
- Portable Dissolved Gas analyser
- Transformer winding resistance meter and turn ratio meter

FRA test set and thermovision camera can cater to number of testing groups operating under GETCO.

11. Event logger & Disturbance recorder are necessary equipment for proper fault diagnosis and must be installed in all substations of voltage 220 kV and above.

12. It is recommended to train and develop strong testing group within GETCO to monitor the healthiness of various substation equipment by using various modern diagnostic tools and to gain experience over the period to interpret the test results, for taking remedial action.