

GT Failure Analysis

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One of the 21/420 kV, 275 MVA Single Phase Generator Transformers at a super thermal power plant failed during the clearance of 400kV Line fault. Thunderstorms and lightning preceded the fault in the area. **Power Linkers** performed **“Root Cause Analysis for this GT failure incident”**.

RCA consists of two parts,

- Analysis of sequential protective relay operation on ‘ETAP’ and
- Insulation coordination study on ‘PSCAD’ to verify the adequacy of lightning protection arrangement.



Regarding the Protective Relay operation, the disturbance records of relevant relays were downloaded and analyzed for coordination among operating time of Line relays, GT relays and Generator relays. The sequence of operation of different relays had to be reconstructed based on recorded fault current values rather than time stamping only on relays as the relays were not time-synchronized.

The result of the analysis confirmed that initially, there was a 400kV Line to a Ground fault which was cleared successfully by the Line protection relay and breaker within 3 cycles.

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After that, the line auto-reclosed after one second. The auto reclosure was also successful. However, GT tripped on its internal fault while supplying a short circuit current to the line fault. Subsequently, when GT was inspected in the vendor's presence, extensive deformation of windings was observed.

Regarding the review of existing lightning protection, the system comprising 400kV line, buses, Line LA's and GT's was modelled in PSCAD. The overvoltage appearing at GT bushing was worked out for,

- A range of impressed surge currents from 20 kAp to 80 kAp.
- The simulations were done for the front time of 8 μ sec as well as 1.2 μ sec.
- Also, the point of surge injection was varied from very near the substation to the far end of the line.

In all cases, the simulation results indicated that existing 360kV LA's provided adequate protection with a margin of more than 15% over transformer BIL of 1425 kV. Also, the location of LA with respect to transformer was checked for any abnormal increase in residual voltage, and it was found to be in order.

Based on the analysis results of ETAP and PSCAD, it was concluded that the GT failed when supplying Line short circuit current. This is due to large short circuit forces exerted on winding, resulting in mechanical failure of GT winding structure and subsequent insulation failure. The winding had collapsed due to inadequately designed winding support structures against short circuit forces. Although the short circuit duration was short (3 cycles), the GT failed, confirming the poor Transformer design.

It was recommended to the customer to get the short circuit design of the new/rewind transformer vetted by an external Transformer Design consultant and or offer the new transformer for short circuit testing at a High Power Testing Laboratory in India or abroad.



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