How we saved a Generator (in fact two), again!

Background

It was just another day and another morning of January 2019, on which we received a call from a new Customer in Metal Sector, from Chhattisgarh. And urgently, they wanted us to test and commission an old 10 MW, 11 kV Generator along with its relaying, schemes and complete testing.

On enquiring about such urgency, we learnt that their original Generator rated 12 MW, 11 kV got burnt (stator) and was sent for repairing, this 10 MW was taken on rental basis and a temporary solution. As we all know that in our industry, Generator failure is nothing less than an air-crash and this criticality warranted extensive and methodical analysis like an air-crash investigation. Hearing this, the day went into a tizzy and we immediately started preparing a checklist (we'll see it later in a diagram) to find out the Root Cause. And unless we find the Root Cause and solve it, this rented Generator was in danger and the upcoming repaired Generator too!

We immediately dispatched 2 of our engineers along with the test sets required, by the first flight available and were soon on the job. In less than a day, we were up and working.

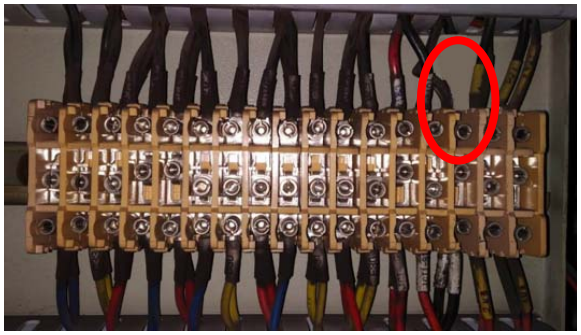
Findings- at Site

- The initial forensics were found from the fault records of the Relay. We learnt that the Relay (and GCB eventually) was tripped on NPS protection, which is normally a time delayed protection. It was a surprise, because normally when such fault occurs (stator failure), other protections take care, NPS is something like last line of defense.

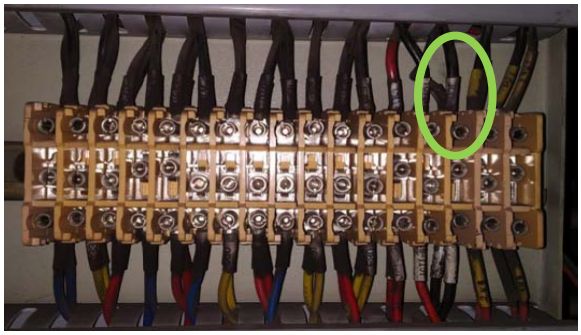
- So, such a surprising observation just at the start of the job prompted us to be extra vigilant. This warranted us for in-depth and thorough checking of the protection system.

- And then came the moment of reckoning, and you know from where? NCT wiring was the culprit for the Generator burn-out! Least expected fault for a Protection Engineer so to speak (It was found while carrying out Stator Earth Fault scheme checking).

- Following actual images clearly show the fault. So, 90 % Stator Earth Fault Protection (51S) did not operate due to non-wiring of NCT secondary S2 to Relay. Generator kept running on this serious a fault which finally led to heating and eventually, NPS operation operated on time delay. But by the time NPS operated, the damage was already done.



Seen here is S2 missing (to Relay)



Corrected by new wiring

Stator Burnt

Disconnected Winding

- NCT, which is used for Stator E/F Protection, was wired up to TB in CRP correctly. But from TB to Relay, wire S2 was missing/not connected on Relay. So even in case of Stator E/F, Relay wouldn't have sensed nor operated nor tripped the relevant breakers. This fault was simply corrected by connecting a 2.5 sq. mm. wire.

- Differential Protection setting was found high, besides, the reference for the settings was not available, we recommended to furnish us the OEM data, compiled during commissioning and to carry out the fresh Studies on Relay Co-ordination, Power System and Load Flow.

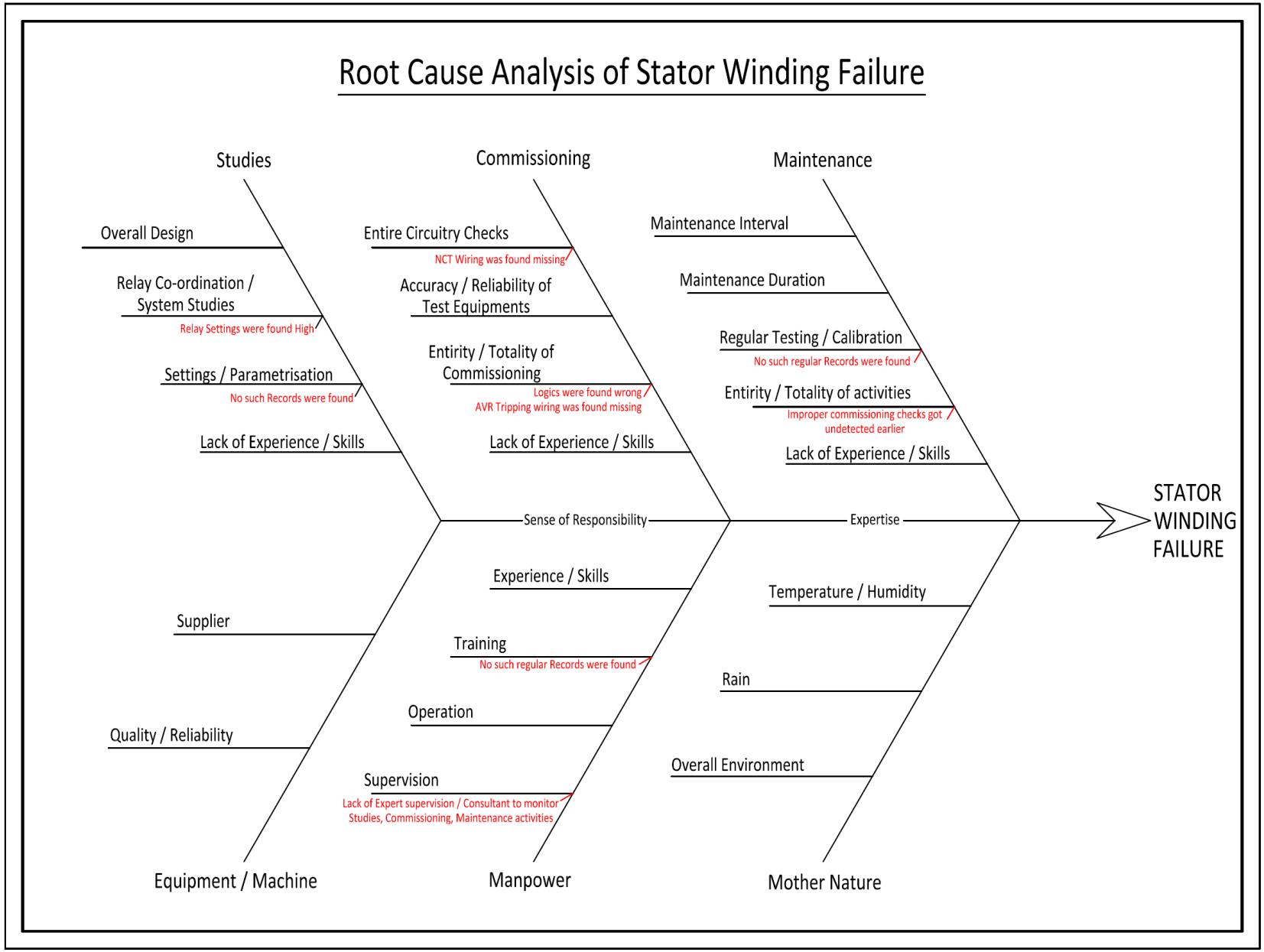
- Suppose both the above protections, Stator E/F and Differential, are alright and operate and generate alarm and trip signals faithfully. And as we all know, both these are Class A protection and must cut the very source of the fault. Here in this case, it's AVR. And you know what we found? AVR could not be tripped because inter-panel wiring was not done. Corrected and now stands rectified.

- Reverse Power and Forward Power Protections were set but with wrong logic. Logic was so wrongly set that neither Alarm could be generated nor Tripping! With the set logic, these protections were rendered useless. Corrected by changing the logic.

- Similarly, this wrong logic error was observed in Under Voltage, Under Frequency and Over Frequency Protections. All these were set alright, but the set logic didn't let these protections generate any Alarm or Tripping signals, imagine! Corrected by changing the logic.

- LBB Protection tripping was assigned to Output No. 3, but as per the OEM Manual of the Generator Protection Relay, this Output No. 3 must be used for other designated functions and not this. Corrected by changing the logic and wiring.

- Following Diagram will help us understand this critical event better.


Root Cause Analysis of Stator Winding Failure
Studies
Commissioning
Maintenance
Overall Design
Relay Co-ordination / System Studies
Relay Settings were found High
Settings / Parametrisation
No such Records were found
Lack of Experience / Skills
Entire Circuitry Checks
NCT Wiring was found missing
Accuracy / Reliability of Test Equipments
Entirity / Totality of Commissioning
Logics were found wrong
AVR Tripping wiring was found missing
Lack of Experience / Skills
Maintenance Interval
Maintenance Duration
Regular Testing / Calibration
No such regular Records were found
Entirity / Totality of activities
Improper commissioning checks got undetected earlier
Lack of Experience / Skills
Sense of Responsibility
Expertise
STATOR WINDING FAILURE
Supplier
Quality / Reliability
Experience / Skills
Training
No such regular Records were found
Operation
Supervision
Lack of Expert supervision / Consultant to monitor Studies, Commissioning, Maintenance activities
Temperature / Humidity
Rain
Overall Environment
Equipment / Machine
Manpower
Mother Nature

Conclusion – How our insightful actions helped the Industry

- Not only our team verified that the newly installed Generator of 10 MW has all the protections available, they verified that it operates, and operates correctly. And generate a correct tripping sequence too. No burning of Generator from now onwards, the way a safe and reliable protection system should be.

- By doing so, we also ensured complete protection of 12 MW Generator which will be put in place after due repairs. Settings need to be verified/corrected with rewinding data but more or less, the machine will be protected.

- Generator is an expensive asset itself, and the loss of production in a continuously running plant due to failure of a Generator can run in to crores. All our efforts are viewing the problems from customers' point and resolving them in totality. Testing, as such, is an isolated job, but when it is done in a way which affects the end-results (production/revenue), then it's profoundly meaningful. And that's what we delivered.

- And at last, we were happy to "wow" the customer, who learnt at last, the difference between symptom-solving-agents and proper Doctors.

- The above are in fact the major problems found and corrected. Though, during our very busy 3-days (and nights too) at site, we also observed many minor abnormalities and corrected as many as possible. Well, to know more, call/write to us, we'll be happy to save your assets too!

  And if you're looking for a dedicated agency who understands the direct link between your assets and your revenue, we'll be happy to assist you, anytime, anywhere.