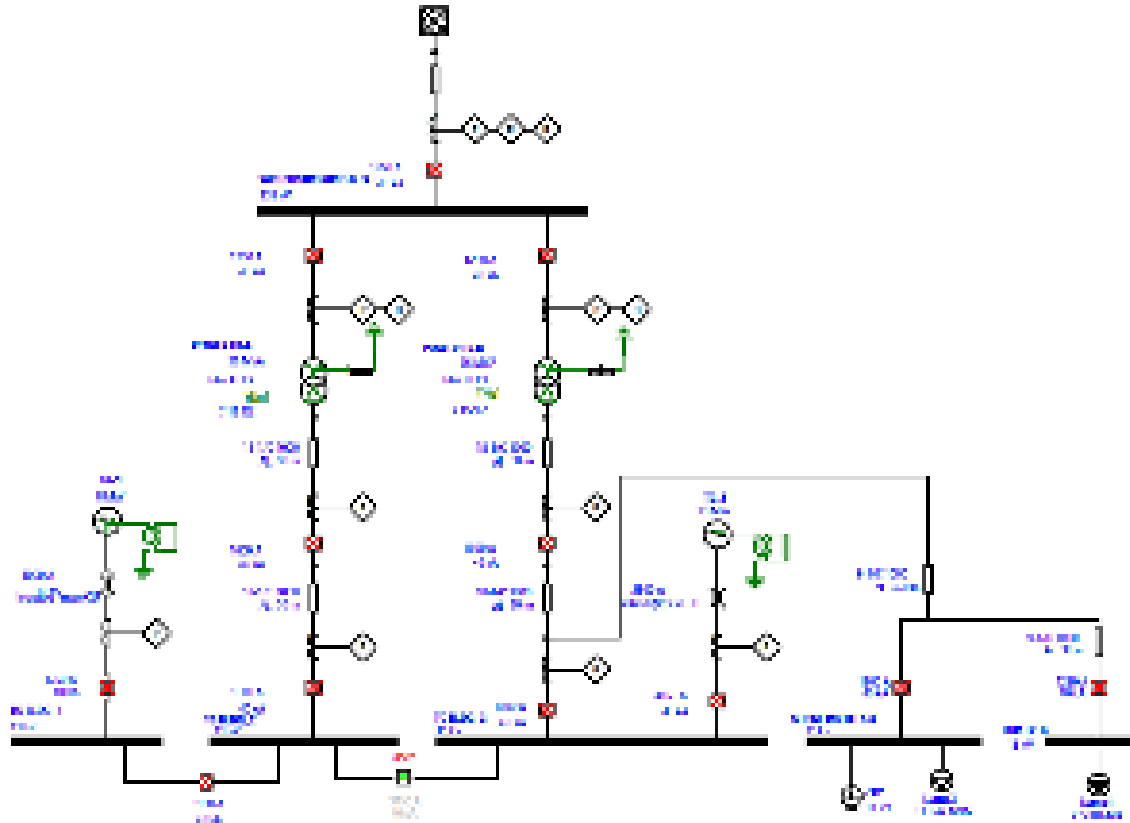


# Improper System Earthing : Loss of Production, Busting of Power Cable and Power Transformers

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Published on June 2, 2022



11 kV Power Bus with 4 Source, Delta Connected Power TR and R Earthed TGs



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3 articles

## **Background**

Power System Study is an important part of any Plant Electrical System. It depicts loopholes in the Protection System, Required upgradation and enhancement in the functionalities of existing system for safety.

Usually we submit detailed technical report with in-depth explanation for every observation and recommendations, also with briefing about its importance, however user may opt out some of the cost loaded changes to avoid burden in budget considered for FY. However to save some lacs, they usually end up paying in multiples of initial cost needed for enhancement.

Presenting here, one such incident which leads to Too many Blackouts, and Failure of 25 MVA, 132/11, Ynd1, Power Transformer twice within a span of 2 years.

### Normal Plant Operating Philosophy :

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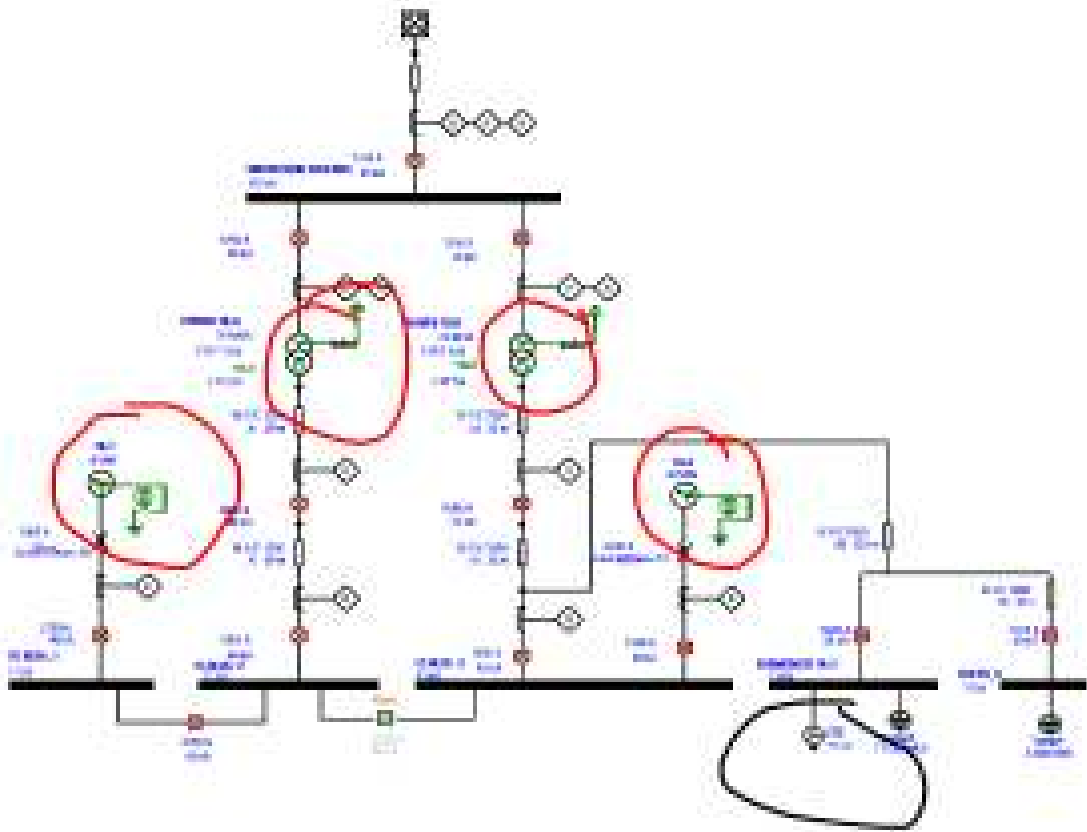
Total Load is being catered by 4 nos. of Source :

- TG - 1, 11 kV, 8 MW
- TG - 2, 11 kV, 33 MW
- Power TR - A, 132/11 kV, 25 MVA, Ynd1
- Power TR - B, 132/11 kV, 25 MVA, Ynd1

All these 4 sources makes 2 Circuits :

Circuit	Voltage Level	Sources Operating in Parallel	
Circuit - 1	11 kV	TG - 1, 11 kV, 8 MW	Power TR - A, 132/11 kV, 25 MVA, Ynd1
Circuit - 2	11 kV	TG - 2, 11 kV, 33 MW	Power TR - B, 132/11 kV, 25 MVA, Ynd1

As we can observe in shown SLD, all the 4 sources were clouded and highlighted in **RED** on 11 kV Bus.



- There are two NGR with TG-1 and TG-2 limiting to fault current at 100 A on 11 kV.
- Earthing Transformer was also available in 11 kV circuit network, limiting to fault current at 100 A, it is clouded in **BLACK**, shown in SLD above.

## NGR Configuration

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Both the Power Transformers are Delta Connected in on secondary side, 11 kV and Both The Generators are Earthed through 100 Amp NGR to limit the fault current.

Additionally, there are 2 nos. of Earthing Transformers (Only 1 shown in SLD here) provided in each circuit to keep system earthed in absence of any Generator and NGR.

It was recommended to keep Earthing Transformer always in line so as to avoid system in floating during Is-landed condition.

Now in Circuit - 2, due to problem in VCB of required Earthing Transformer was kept open and isolated, since complete 11 kV System was earthed through NGR of TG only for circuit – 2 as illustrated in fig. below :

## Operating Practice :

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To avoid reflection of heavy inrush on TG and consequences such as black out, overload, stress on winding and voltage dip, plant team was charging downstream load of 18 MVA Ferro (almost Inductive) on Grid Power, through 25 MVA Transformer.

Once they charge 18 MVA ferro, after observing stability in system, they use to synch TG with Utility closing VCB shown in fig.

## Findings

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Let us revise the operating condition :

- NGR of TG is kept closed
- Earthing Transformer was kept opened due to problem in its VCB.
- So, whenever they charged 18 MVA ferro directly on Utility Power, it was Floating System i.e. No earthing in entire circuit until they Synch TG with Utility.

### 1st Incident Reported :

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- After charging of 18 MVA ferro, when they tried to synch TG with Utility, Relay at Synch Breaker issued Tripping on Earth Fault.
- Overlooking the fault they retried the Synchronisation and again it issued Tripping on Earth Fault.
- Assuming mal-operation of relay, they Raised the Relay setting to Higher value and again tried to Synchronise Power, and they made it too..
- But, after about 1 second, TG - 2 got tripped on Earth Fault, as it was next in circuit for co-ordination after Synchronising Breaker.
- Simultaneously, one of the run of Power Cable from Power Transformer to 18 MVA Ferro got busted.

### Root Cause Analysis :

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- There was Earth Fault in one of the Run of Power Cable to 18 MVA Ferro.
- Since, before Synchronisation system was un-earthed (Floated) it was not reported.
- When they tried to synch system with TG, Earth fault got return path from TG Neutral and leads to tripping of TG on earth fault as setting of relay on synch breaker was raised above TG relay setting.

No one focused on un-earthed (floating) system. And continued plant operation by jointing power Cable from punctured spot.

### 2nd Incident Reported :

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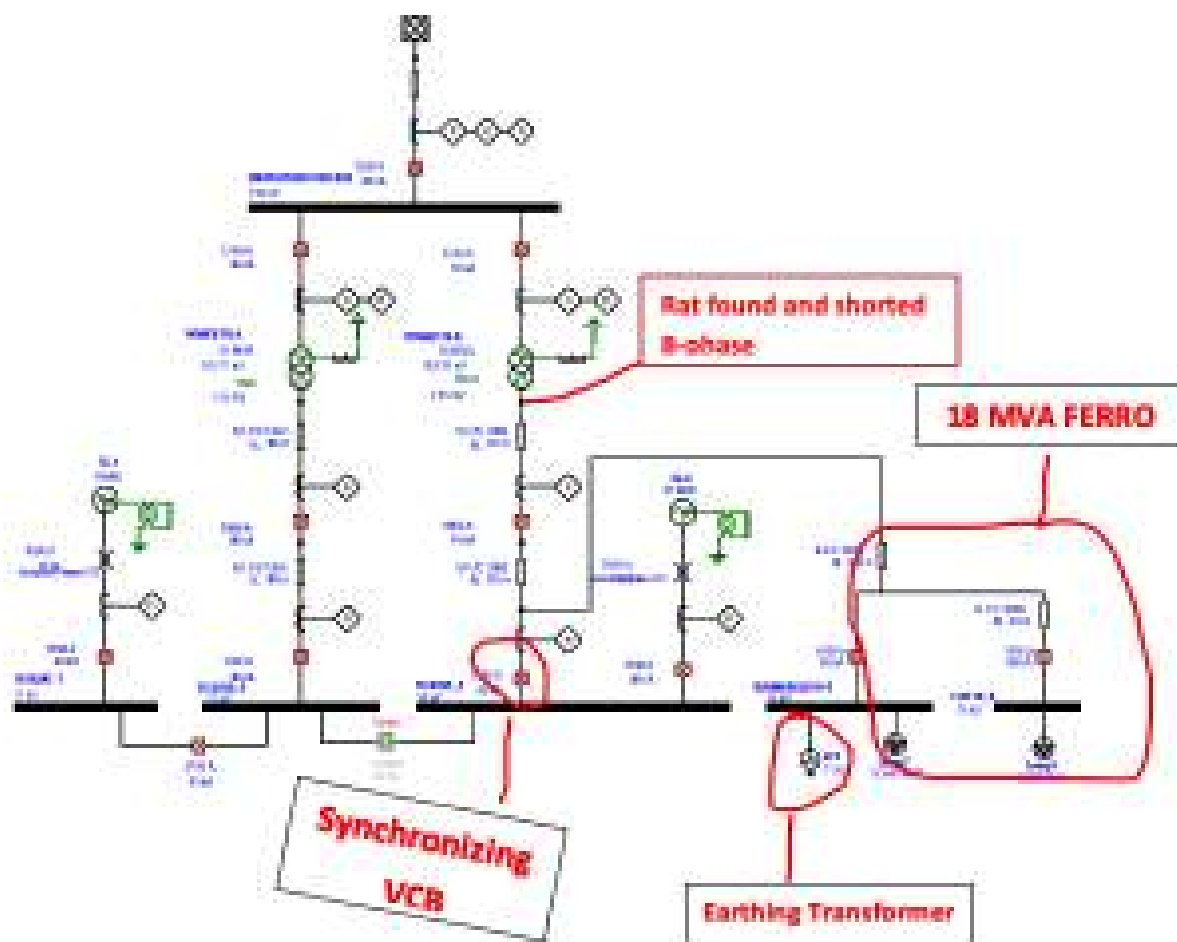
PS :

**Operating philosophy was same as narrated above.**

**Relay setting of Synchronising breaker was still kept higher, without considering its importance.**

**1st incident was not analysed, nor does anyone worked on retaining Settings or anything related to Earthing Transformer.**

- Now, Plant was running on maximum capacity, with TG synched with Utility.
- Earth Fault occurred on secondary side of Power Transformer, i.e. Rat entered and shorted B-phase with ground as we can see it in figure.



- 2 source ( Utility and TG) were contributing to the fault, however return path to the fault was through Neutral of Generator only.
- Amid higher setting of Relay at Synchronising Breaker, Relay at TG issued Tripping command and TG was isolated from system.
- However, fault in the system was still uncleared as it was being fed by Utility.
- Also, due to isolation of TG, complete 11 kV system became un-earthed (Floating).
- Now, though there was a B-Earth fault, but return path to the fault was not available, circuit was incomplete and fault remained un-cleared.
- Now this would continue till second puncture occurs and circuit gets completed and Phase – Phase occurs for delta system.
- Also, due to single Phase-Earth fault on delta side, there was no reflection on primary side of Transformer.
- Amid, lasted fault on secondary side, it created voltage stress in winding and leads to **Winding Failure of Transformer**.

### Root Cause Analysis :

- System was Grounded through only NGR of TG.
- Relay setting of Relay at Synched Breaker was raised higher and was not Reverted to original, leads to Tripping of TG Relay and leading to Un-earthed (Floating ) System.

- Since, second source was utility, and B Phase - Earth fault was persisting but was not getting path to complete the circuit.
- Due to uncleared fault, there was a voltage stress and it remained for such a long duration, that it leads to failure of Transformer winding.
- Now, this was not due to one-time fault, but every time whenever earth fault has occurred during Un-earthed condition, it has remained in system until failure and/or black outs

**PS : This time it was reported as we have conducted Power System Study and Relay co-ordination, however in past, they have also suffered failure of Generator.**

### **Conclusion :**

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- System Earthing at Source bus is of supreme importance
- There must be logic OR SOP for keeping Neutral grounded among available multiple NGR/NGT.
- Also, we can't keep all the NGRs in line, looking towards Generator Damage curve. So grounding of Neutral through NGR/NGT must be identified and planned to avoid any major issues.
- Power System Study is the first step to identify all such major and minor loopholes, which may in-turn result into system wide black outs and equipment failure.
- All the recommendations and observations after Power System Study are to be addressed and must be given importance for implementation setting priority.
- Transformer is a very important asset, and the loss of production due to mal-operation of its protection system, can run into crores. All our efforts are viewing the problems from customers' point and resolving them in totality.
- The above was in fact the major problem found, we also observed some minor abnormalities and corrected them too. There could be many reasons for mal-operation of Transformer Protection System and can be addressed on case-to-case basis. To know more, you may call/write to us.

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