

Management of Earth Faults in Power Distribution Network

When an earth (ground) fault occurs in an HT electrical distribution system, a heavy current flows through the affected portion of the system. This will trip the feeder breaker and disrupt the power in that branch of the distribution system. It is essential that the power resumed as soon as possible to the consumers, as the disrupted power means a direct loss of revenue to the utility company and also it creates dissatisfaction amongst the consumers. In such case it is essential that the fault is located quickly so that the faulty portion can be isolated and power can be resumed.

The conventional method for locating the section in which the fault has occurred is a trial and error method. In this method section by section power is resumed. If the faulty section persists then the breaker will trip. So at end of several trials the faulty section can be determined, it then is isolated and the power is resumed and/or re-routed through other ring main distribution. The isolated cable can be repaired or replaced later.

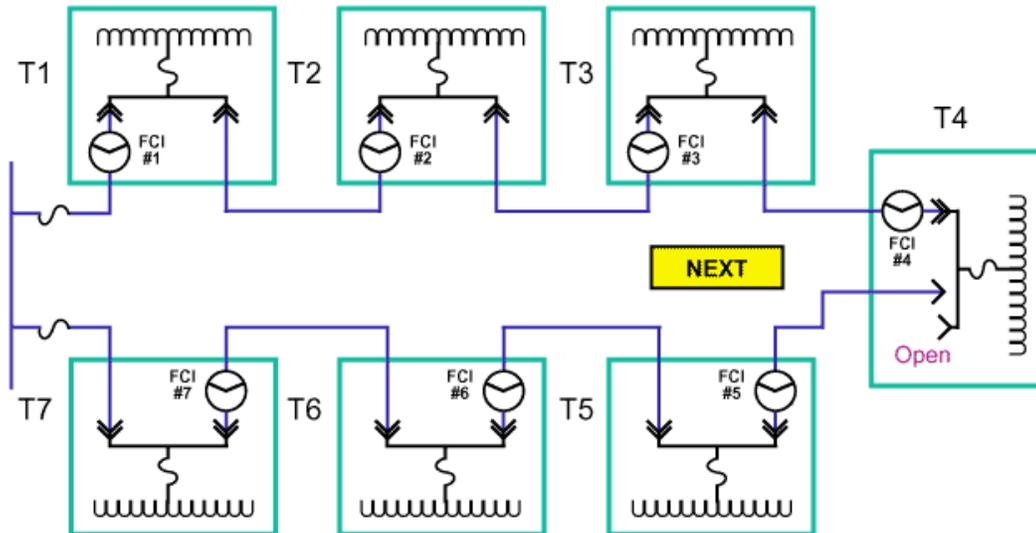
With the conventional method, being a trial and error method, a long time may elapse before the fault can be detected. It requires a team of skilled / experienced people to locate the fault and also requires co-ordination between the distribution point where the breaker is located and the fault testing point. Every failed trial trips the breaker and fault stresses are subjected to the switchgears, breakers and cables in the series.

Earth Fault Indicators (EFI) can be installed at substations to detect the earth fault. In the event of an earth fault the EFI at substations that are affected by the fault current will display a fault flag. The remaining EFIs will remain in healthy mode. Even when the breaker trips and the power disrupt, the fault flag will remain in the faulted position in the affected substations. To detect the faulty section, a person has only to trace two consecutive substations with faulted and non-faulted flag. The fault is in the cable connecting these two substations. The cable between these two substations is quickly isolated and the power can be resumed from the ring-main distribution system.

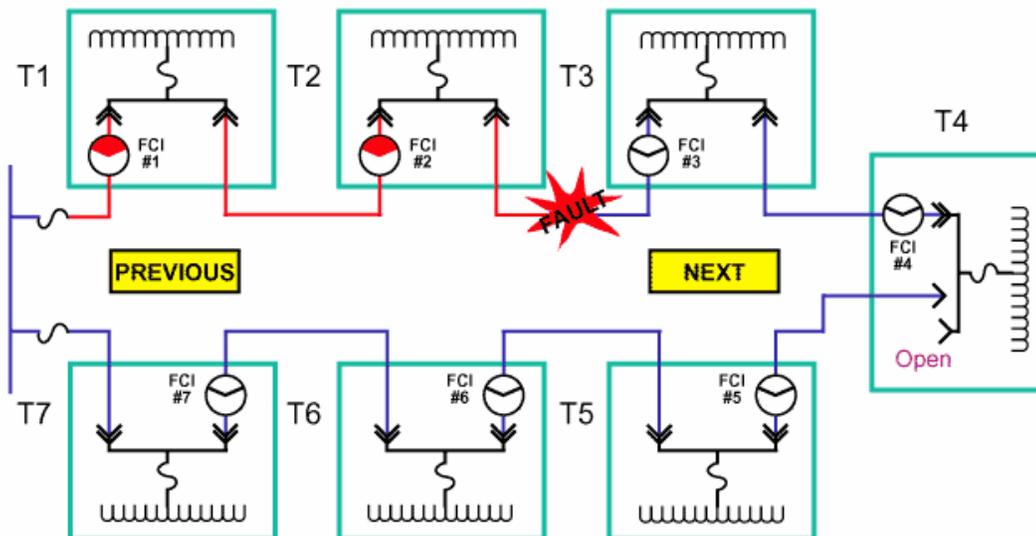
Earth fault Indicators applied to an underground cable system can reduce the outage duration as much as 60%, as a major amount of time is saved in detection of the faulted location.

The process of Earth fault management is described step-by-step using the following diagrams.

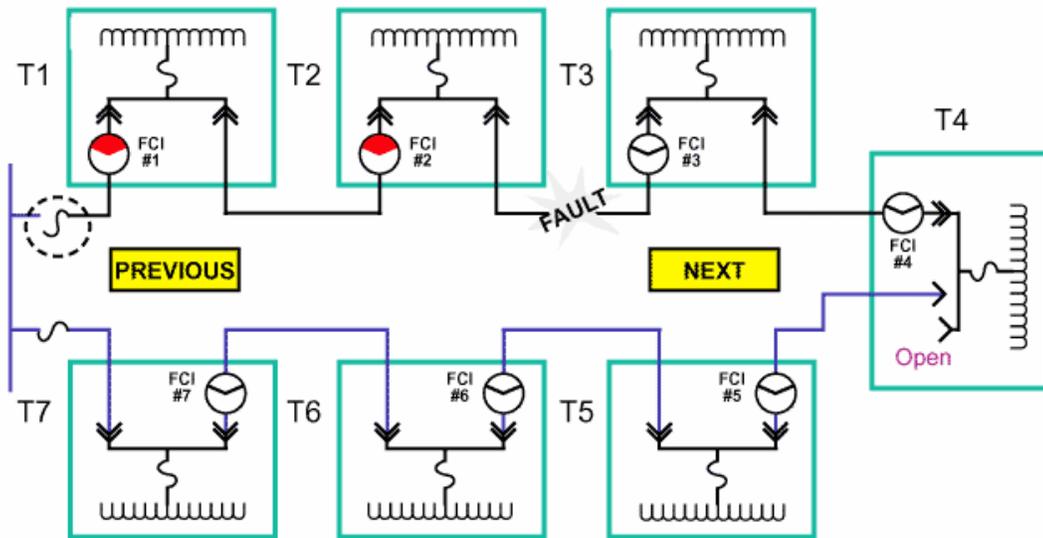
1. The supply in healthy condition. Here T1 to T7 are distribution transformer sub-stations connected in ring-main configuration. The earth fault indicators FCI #1 to FCI #7 are all in healthy condition.



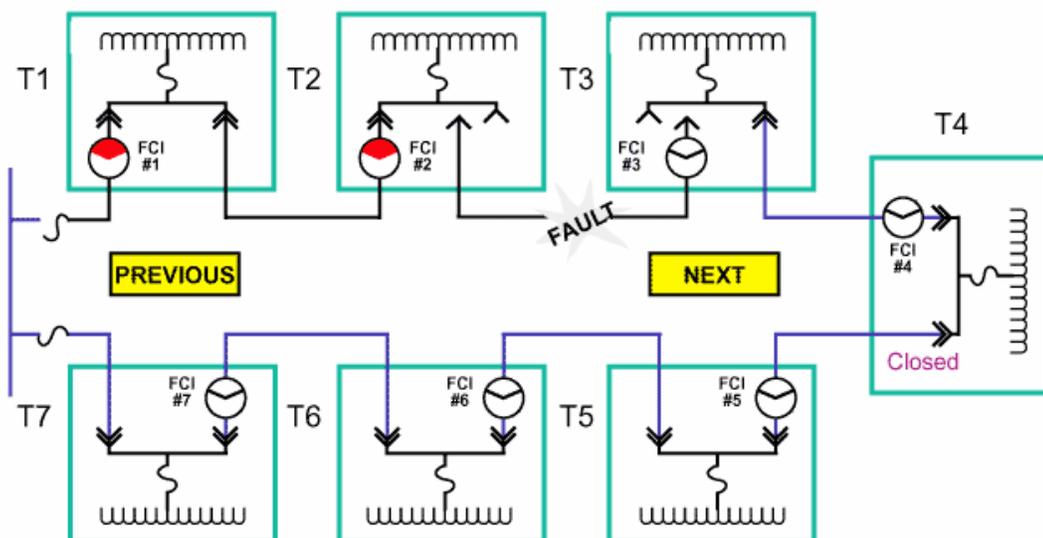
2. An earth fault occurs on the cables between T2 and T3. The fault indicators FCI #1 and FCI #2 will turn red indicating the fault.



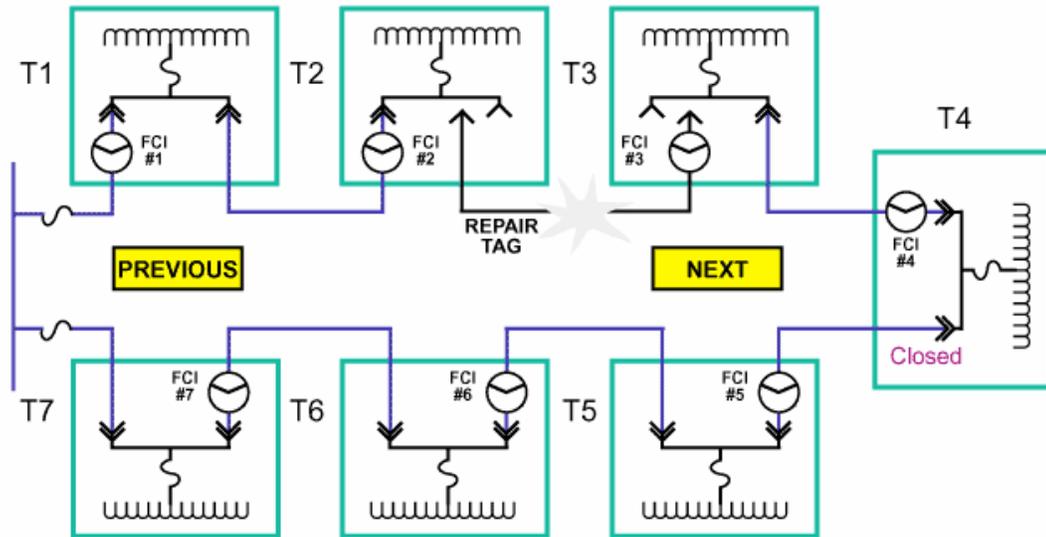
- The breaker connected to T1 incoming will trip and the power will be disrupted in distribution T1 to T4. Notice that the fault indicators FCI #1 and FCI #2, still show the fault even when the power is disrupted.



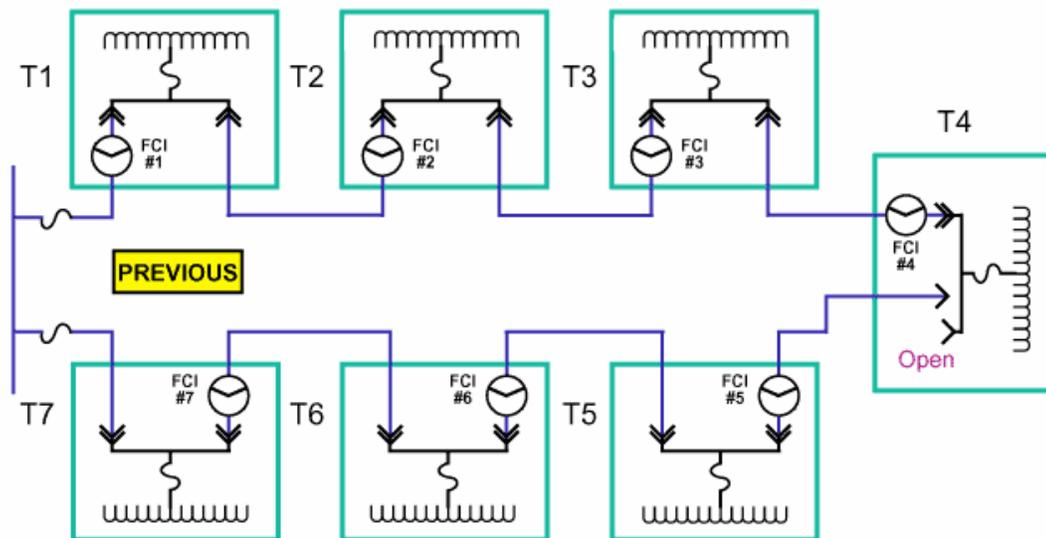
- The substations are inspected and when it is found that two consecutive faulted and non-faulted locations are T2 and T3, it is determined that the fault lies in the cable between T2 and T3. The cable is isolated, The ring-main at T4 is connected hence the power is resumed in T3 and T4.



- A Repair Tag is attached to the faulty cable and breaker supplying to T1 is switched on, hence the power is resumed in all the sub-station now. Notice that as the power is resumed, the FCI #1 and FCI#2 will automatically reset to normal condition and there is no need to reset them manually.



- The faulted cable is repaired or replaced and the system is put back in its original configuration.



(Diagrams courtesy: Hubbel Power Systems Inc - USA)

Advantages of EFI over the Manual Fault Location Method

Installing earth fault Indicators in the distribution system has many advantages. The following table shows a comparative advantage of using EFI v/s the manual fault location method.

Sr.	Manual Method	EFI
1.	Location of fault is time consuming as it is a trial and error method and various substations might have to be operated before locating the fault.	Faulty section can be quickly pin pointed by simply locating the consecutive faulted and non-faulted indicators.
2.	A team of people may have to be deployed to locate fault as trials have to be taken.	Only one person can quickly go through the defined route to locate the fault.
3.	Operating the switchgears under the faulted condition will create mechanical stress / damage and affect the life of the switchgear or incur more expense for spares.	As the switchgear is not to be operated, the stresses of operating it under faulted condition is avoided altogether.
4.	Revenue loss to the electricity company due to the delay in resuming the power.	The delay in resuming power is minimized.
5.	Not possible to integrate in an automatic or network system as this is only a manual procedure.	The output contacts can be connected to network, additional indicators or SCADA to have better and faster control of fault location.

These are some of the additional advantages of applying the EFI

- Increased customer satisfaction.
- Increased cable life as no need to operate under faulty condition.
- Easy to use. Even one person can quickly locate the faulted section.
- Allow system planners to extend service life of the cable.
- Lineman's safety and confidence increases.

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