
# Converting Solidly Grounded Transformers to High Resistance Grounded Systems in a Pulp and Paper Mill

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The first step in addressing arc flash is to reduce the probability of exposure at the inception of the arc fault. This can be accomplished utilizing High Resistance Grounding (HRG) systems.

It is well known that up to 70% of all electrical faults begin as single-phase-to-ground faults. Therefore, reducing the energy produced by this type of fault will reduce the likelihood of a single phase to ground fault to propagate to a phase-to-phase or three-phase fault.

High resistance grounding is the only method to date that will reduce the probability of exposure before a significant phase-to-ground fault arc flash occurs. Other methods will not reduce the probability of an arc flash occurring and begin mitigating the arc flash only after the fault has occurred.  That is the reason why NFPA-70E (Z462 in Canada) recognizes high resistance grounding as a mitigation technique for arc flash.

In the studied facility, a significant decision-making process was conducted to determine the best approach to give the facility the most protection for their employees. To do this, the owners chose to implement arc flash reduction in a two-pronged attack; first, limit the probability of an arc flash occurring and second, reduce the arc flash incident energy if more than a phase to ground fault occurs. Arc flash mitigation was accomplished through a number of strategies:

**1.** Application of high resistance grounding on all the low voltage transformers to reduce the probability of occurrence. As per the IEEE 1584-2018, the application of high resistance grounding does not increase the incident energy of the arc flash.

**2.** Installation of low voltage power circuit breakers digital relays on most low voltage breakers for tighter tripping control;

**3.** Installation of electronic protection relays on low voltage substations  which incorporated Maintenance Mode switches programmed into the relays; and

**4**. Installation of 15kV primary fuses which have faster trip curves

The facility also recognized the disadvantage of not having the neutral available to service line-to-neutral loads. This necessitated the installation of isolation transformers to service these loads. This also made the system safer by exposing the single phase loads to much lower bolted fault current.

Even with the added cost to the project, there were overwhelming advantages observed by utilizing high resistance grounding system and the facility felt it was well worth it since they wanted to not only reduce the probability of an arc flash occurrence, but also reduce the incident energy to protect their employees.

## Advantages

**1.** The facility saw a dramatic increase in continuity of power even in the event of a ground fault. This kept the operations running and gave the time needed to swap to back up systems without disrupting the operation.

**2.** An unexpected advantage observed was the decrease in motor failures/repair costs which directly correlated to the reduction of operational low voltage electrical downtime. This represented a significant cost avoidance for the facility