BE ALERT TO DANGER POSED BY GROUND POTENTIAL RISE

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Electrical damage from ground potential rise (GPR) has an estimated cost in the millions of dollars a year, but few telecom engineers or service managers in the industry are even aware of the phenomenon.

Electrical damage occurs when there is a high-voltage difference between a grounded communications site experiencing GPR and a remote low-voltage ground reference external to the site. Either high-current source can damage communication equipment connected to a remote location via wireline cable facilities.

Ohm's law dictates that a voltage potential will result when current of any magnitude or frequency flows through a grounding impedance. Power substation GPR is the result of a 60Hz earth return fault current flowing through a substation ground grid impedance. With lightning, a high-frequency 1000Hz to 100MHz current flows through a grounding system structure and generates a high-frequency GPR.

Damage occurs when a high GPR voltage appears on one side of a communications device (or service technician) within an elevated ground reference location during the instant it naturally is seeking a lower ground reference at a remote location. This is the special case of transferrred potential defined in IEEE standard 80-1986. People and equipment most susceptible to GPR usually are located at power substations, power generating facilities and tall grounded radio towers such as emergency 9-1-1 locations, cellular radio sites and microwave communication buildings.

AT A GLANCE

GROUND POTENTIAL RISE

- Damage occurs when a high GPR voltage appears on one side of a communications device within an elevated ground reference location during the instant it naturally is seeking a lower ground reference at a remote location.
- The most important consideration when protecting equipment from a GPR is the ineffectiveness of standard electrical protection methods.
- To protect personnel and equipment, follow codes and IEEE standard installation procedures while using special high-voltage protection devices.
- Properly protected GPR locations designed and maintained by trained employees will reduce overall costs, improve productivity and increase circuit reliability. Ignoring GPR can result in costly repair and legal bills.

There are recorded cases where 60Hz GPR lasted more than 15 minutes, causing millions of dollars in damage. But a lightning strike ground potential may last a very short time (50 nanoseconds to 10 milliseconds). These strikes cause most of the electronic circuit damage on wireline facilities at radio tower sites. They may not destroy circuits immediately, but may weaken individual components that fail later.

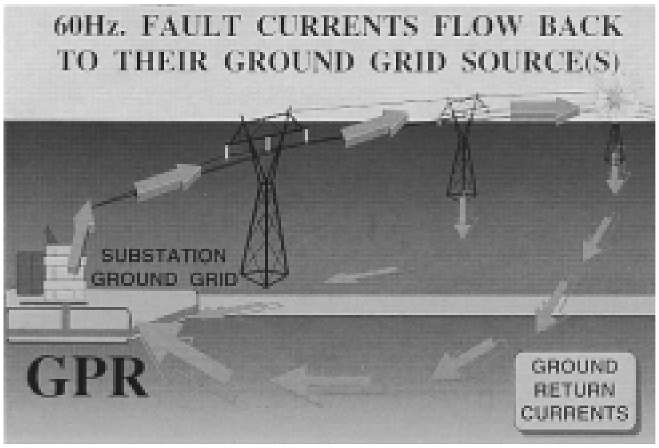
How are GPR damage problems solved? A series of field-proven national standards provides methods for protecting people and equipment from GPR. These documents have existed for years, but most field engineers and technicians seem unaware of the valuable information provided. The most important and useful standards include:

- NFPA 70-1992—National Electrical Code (NEC);
- ANSI/IEEE Standard 80-1986—Guide for Safety in AC Substation Grounding;
- ANSI/IEEE Standard 367-1987—Recommended Practice for Determining the Electric Power Station Ground Potential and Induced Voltage from a Power Fault; and
- ANSI/IEEE Standard 487-1992—Guide for the Protection of Wire-Line Communication Facilities Serving Electric Power Stations.

Although most of these standards address protection from GPR due to 60Hz fault currents, lightning strike energy applications basically are the same in considering higher frequency impedances. Both currents generate a GPR and have potential to harm personnel and damage or destroy communication facilities.

The most important consideration when protecting equipment from a GPR is the ineffectiveness of standard electrical protection methods using gas tubes, metal oxide varistors (MOVs), silicon-controlled rectifiers (SCRs) and SASs (four-layer semiconductors). These devices normally are placed at each end of a cable communication facility and are designed to direct foreign voltage impulses into a grounding system. During a GPR, these devices merely offer an additional path to remote ground reference and actually provide a path for current to flow in the reverse direction from which they were intended to operate. Thus, no matter how good standard protection devices are, equipment or cable facilities will become part of an electrical path between the GPR site and remote ground.

Today's standards limit the use of basic electrical protection devices and methods at power substation locations. The voltage level defined in IEEE 487-1992 is below the level where standard



station protectors do not fuse, explode or cause a fire hazard. The limit of GPR was established at less than 100v-peak-asymmetric and applies only to a small percentage of today's substation locations. Due to the nature of lightning-induced GPR, chances of a high-energy strike exceeding this limit are high.

So how to protect personnel and equipment from GPR at higher levels? Follow existing national codes and IEEE standard installation procedures while using special high-voltage protection (HVP) devices—such as isolation transformers, optical couplers and fiber optics—intended to protect against GPR. These devices and related facilities will provide a high dielectric strength barrier between grounding potentials on a full-time basis and isolate communication facilities from transient voltage damage before, during and after a GPR incident.

Communications engineers and service managers should not turn a blind eye to GPR damage because they believe special high-voltage protection devices are more expensive than standard gas tubes. Consider ongoing costs for continuously replacing damaged equipment year after year. Also, labor repair costs can equal the cost of any properly protected GPR site. And don't forget personal safety issues: employees working in, on or around equipment connected to a remote ground potential are at a safety risk if they are not trained properly and equipped to work there.

Properly protected GPR locations designed and maintained by trained employees will reduce overall costs, improve productivity and increase circuit reliabilities over any time period. Ignoring GPR today always will result in costly repair and legal bills in the future. ■

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