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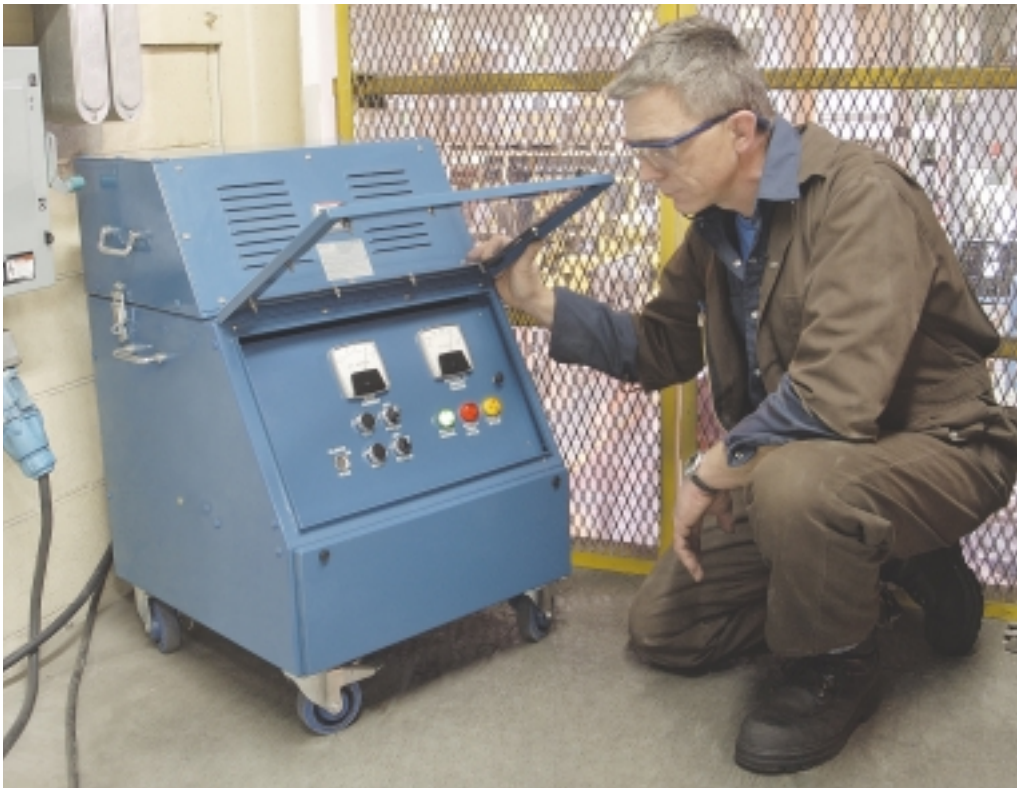
A new approach to ground fault protection

By Andrew Cochran

One of the constant issues facing industry is electrical reliability. Significant focus, attention and capital is applied to back-up power – generator, battery and UPS systems – to protect critical processes and power factor correction equipment. But an often-overlooked issue is electrical ground faults. Empirical data indicates that around 80 per cent of all electrical interruptions are attributable to grounding problems and that ground faults are the leading cause of motor failure.



Vic Galamb of Collins Electric uses IPC's portable pulsing ground fault detection system to locate faults at the Narmco autoparts manufacturing facility, without disrupting production.

Grounded vs. ungrounded

The Narmco Group is a major automotive parts manufacturer with a number of manufacturing operations, including five clustered in southwestern Ontario. The electrical maintenance for all five of the facilities is undertaken by Collins Electric. Narmco, like the majority of automotive industrial facilities, operates an ungrounded electrical system. The reasoning behind the prevalence of ungrounded systems in automotive industrial facilities appears to be historical. Prior to the emergence of high-resistance grounding in the late 1980s, the only choice, when process continuity was required, was an ungrounded system. Of course, a significant number of industrial facilities, both automotive and non-automotive, were built before the 1980s, however, even those constructed today are often based on past project specifications with few upgrades undertaken on the grounding specification.

The choice of operating an ungrounded system in industrial facilities is supported by IEEE 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems. In section 1.4.2 it states that "Two principle advantages are attributed to ungrounded systems. The first is operational: the first ground fault on a system causes only a small current to flow, so that the system may be operated with a ground fault present, improving system continuity. The second is economic: no expenditures are required for grounding equipment."

However, ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service and, in fact, have quite a few disadvantages. For example, it's not possible to locate the first ground fault without shutting the system down. Excessive overvoltages can cause insulation failure and equipment damage. And,

there is the potential for a second fault to occur before the first one is removed, leading to burn downs. (See IEEE 242-1986 7.2.4.)

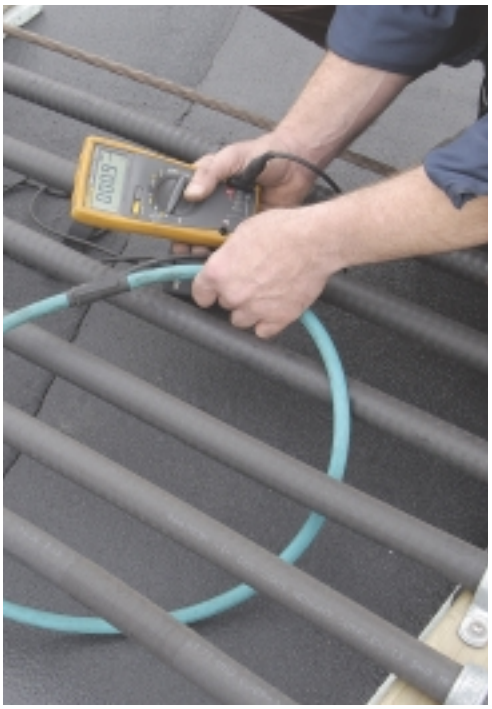
With a high-resistance grounded system, fault currents are limited by a grounding resistor to non-damaging levels (typically 5 A), which allows for continual use of the system and process continuity until the fault can be located and cleared by qualified personnel.

Ungrounded fault removal

With a full understanding of the possible consequences of a second ground fault on an ungrounded system, the maintenance personnel at Collins Electric were committed to removing faults as quickly as possible. There were two major roadblocks, however. One was the time required to manually find a fault of unknown location. Ungrounded systems employ ground detectors. Usually three lights indicate whether there is a ground fault or not. When the system is healthy, all three lights illuminate equally. When a fault occurs, the light corresponding to the faulted phase will go dark and the other two will illuminate more brightly. These detectors show the existence of a ground on the system and identify the faulted phase, but do not locate the ground, which could be anywhere on the entire system. With literally miles of conduit and power conductors inside a facility, the typical approach for locating the ground is time consuming and disruptive. It's necessary to individually close each circuit breaker inside the facility and watch the ground detectors to determine the faulted circuit, i.e., watch for the return of three equally illuminated lights.

The second roadblock was how to undertake a time-consuming trial-and-error fault-finding program yet minimize the disruption to production. At Narmco, where downtime and loss productivity is counted in tens of thousands of dollars per hour, causing interruptions to production processes by tripping and resetting circuit breakers was not an economically acceptable option.

The only solution was having three maintenance personnel perform fault-finding missions on weekends or off hours when tripping and resetting the circuits wouldn't directly impact production. However, since the machines had been shut down at the end of the production week, it was necessary for the maintenance people to restart all the equipment before they could start searching. If, and often when, they were unsuccessful in locating the fault in the relatively short time period that remained, a further week had to pass before they could start searching again. During this time, a second fault could occur, which could result in equipment damage.



The built-in pulsing circuit alters the fault current, creating a two-stage pulse that can be traced using a handheld meter and current sensor to quickly locate a fault.

Temporary grounding

Narmco and Collins Electric realized there would be numerous advantages in converting to a high-resistance grounded system, including greater safety, freedom from excessive system overvoltages that can occur on ungrounded systems during arcing, and easier detection and location of ground faults when they occur.

However, a full-scale conversion would take capital, time and resources. At such a large facility, one fixed, high-resistance system would be required at each transformer. Although this potential solution was reviewed and budget requests were submitted, the equipment damage and time-consuming fault finding continued. Says Vic Galamb of Collins Electric, "We needed a solution to temporarily convert to a high-resistance system, locate the fault quickly and not disrupt production."

Since process continuity is assured with a high-resistance grounding system and fault finding is facilitated by using a technique of varying the fault current, a product was needed that allowed this on a temporary basis and could be used by Collins Electric at all five Narmco facilities. High-resistance pulsing systems were widely available from a number of manufacturers but all were fixed types that were permanently wall- or floor-mounted.

Collins and Narmco found the ideal solution with the *Turbo Sleuth* from IPC Resistors. A robust, portable unit that temporarily and easily connects to an existing electrical system and converts the faulted system to high-resistance grounding. It uses an integral pulsing circuit to facilitate fault finding where and when required, while ensuring system continuity. The *Turbo Sleuth* contains the fault-limiting resistor, the pulsing circuitry and, if required, an artificial neutral in a single-wheeled enclosure that can be readily moved throughout a manufacturing facility.

By limiting the fault current to a low and non-damaging level, the *Turbo Sleuth* protects production equipment from overvoltages. The built-in pulsing circuit, once selected and initiated by the maintenance personnel, alters the fault current to create a two-stage pulse that can be traced using a handheld meter and current sensor to quickly locate the fault.

"One of the reasons we chose this product," said Galamb, ''was the ease of installation. We simply installed welding plugs at convenient locations throughout the five facilities. Once we knew from the ground detectors that we had a fault, we moved the portable unit to the closest available outlet, connected the unit, converted the system without impacting production and started the pulse. We then used the current sensor loop provided with the unit to trace and follow the fault, dividing the plant into sections to help us quickly zero in on the fault. With five separate facilities, we were also able to use one *Turbo Sleuth* by throwing the unit in the back of the pickup and transporting it wherever we need it."

"In due course, we would like to install some fixed units for permanent protection where we have the most frequent problems," said Galamb. "But for now we've reduced fault finding from days to minutes, and we have seen a dramatic reduction in equipment damage. And, of course, we no longer need to fight with production for the time we need. We can spend our weekends on repairs, not hunting around for faults." ***EB***

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