



Improving Drill Rig Reliability with High Resistance Grounding

How one drilling company cut ground-fault troubleshooting time 80%, increasing uptime and enhancing equipment protection

CASE STUDY

Situation

An oil drilling company, based in Calgary, Alberta, builds and operates oil and natural gas drilling rigs that are used all over North America.

The problem of ground faults

Many drill rigs are powered by up to four generators connected in parallel, and historically have used ungrounded electrical systems. An ungrounded system does not need to shut down when a ground fault occurs on one phase; the faulted phase goes to zero volts with respect to ground. The other two phases go to full phase-to-phase voltage above ground, but there are no large currents, nothing trips out, and the system continues to operate. Such a system has a number of serious disadvantages. Intermittent ground faults can create transient overvoltages throughout the system, which can endanger personnel and cause damage, including insulation failures on motors. And because there is no ground-fault current, when a ground fault occurs on an ungrounded system, it can be very difficult to locate — so difficult, in fact, that some users simply ignore a ground fault and keep operating. This works until a second ground fault occurs on another phase, at which point there is a phase-to-ground-to-phase fault with all the damage that can result.

Ground faults are common events on drill rigs. The rigs get very dirty, explains the company's Electrical Manager, and operators wash them before moving them; there's also rain and melting snow. "And then when they move," he says, "that's when you see ground faults."

The primary method for locating a ground fault on an ungrounded system is a three-light indicator: three bulbs in a wye configuration, with one bulb connected to each phase and the center point connected to ground (on a 480 V system the bulbs are generally pairs of 240-volt bulbs wired in series). Normally the bulbs will glow dimly, but if one phase faults to ground, its bulb will go out and the other two will light up brightly. This indicates that a fault exists, but it gives no information about its location.

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The company was experiencing an average of about one ground fault per month per rig, and because the rigs are used in remote places, easy troubleshooting is very important. However, with hundreds of loads on the system, that was far from a simple task. The only available method was to turn off loads or feeders one at a time to see when the three lights came back on, but that could mean turning off dozens of loads one at a time, in search of the fault. At times, it would take up to two hours for the electrician or worker to find the fault. Not only is that expensive downtime, but the workers could be doing something else more productive.

Because of the hassle, many operators won't even try to find the fault; the reaction tends to be "we'll take care of it tomorrow."

What's more, the voltage-based ground-fault detection devices that were used to find the faults would themselves fail every six to nine months and require replacement at a cost of \$600-\$1500, plus up to four hours of labor, and the associated downtime on that section of the rig. Clearly, something had to be done.

The solution

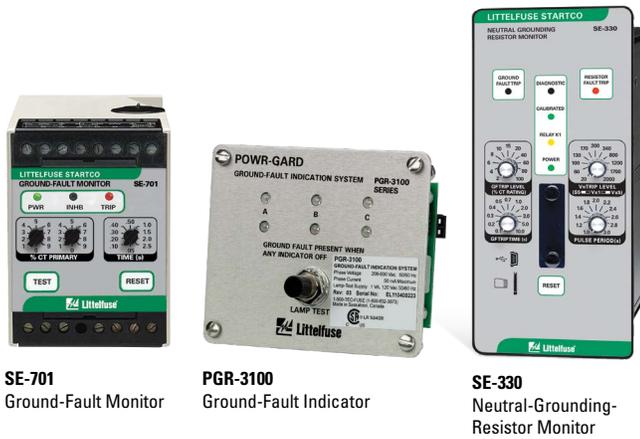
The best solution to the problems of an ungrounded system is to switch to a high-resistance grounded (HRG) system in which the system neutral point is connected to ground through a neutral grounding resistor (NGR). (On a wye-connected system, it is the actual neutral; on a delta-connected system, it is a neutral created using a zig-zag transformer.) When a phase faults to ground, the neutral point rises to phase-to-neutral voltage above ground and a defined current flows through the resistor— usually about 5 amps. Because the system is no longer floating, the problem of transient overvoltages goes away. Also, the current through the NGR can be monitored to indicate that a ground fault is present, and to find the fault location.



Looking for alternatives, the company began considering switching to an HRG system for its drilling rigs in 2012 and they received a recommendation to contact Littelfuse. It started with one rig, putting in a zig-zag transformer and an NGR, and adding a Littelfuse SE-330 Neutral Grounding Resistor Monitor to detect ground faults and monitor the health of the resistor. They also installed a Littelfuse SE-701 Ground Fault Monitor on each of the main feeders to indicate which feeder has a ground fault. Both the SE-330 and the SE-701 connect to the rig's control system to alert the operator and log the event.

With this combination of devices, any ground fault will be immediately indicated with an alarm on the operator's display; the operator can tell not only the magnitude of the fault (anything from a current leak to a solid short) but also on which feeder it has occurred.

When a ground fault occurs and the affected feeder has been identified, the next step is to find which load has the actual fault. It would be possible to do this by checking each with a clamp-on ammeter, but because that would involve opening live electrical cabinets, the maintenance people generally prefer to simply turn off loads one at a time until the three lights on the local PGR-3100 all turn back on.



Results

The results have been gratifying. The time it takes to locate a ground fault has been reduced from up to two hours to about 5-10 minutes, which makes operators much more willing to go out and find them when they occur. "In my mind the big benefit is it helps narrow down the ground fault, therefore making the operator more willing to deal with it," the company says.

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Another advantage of the system is that it logs ground faults in the rig's data acquisition system, which is useful for troubleshooting.

Plans for the future

The company initially installed an HRG system on just one rig, but, "it has been out in the field for over a year. I've talked to the manager of that rig and he's very happy with it; it helps him a lot. So we're moving forward with it in all of our designs." High-resistance grounding is now the company's standard design and all new rigs will be incorporating the system.

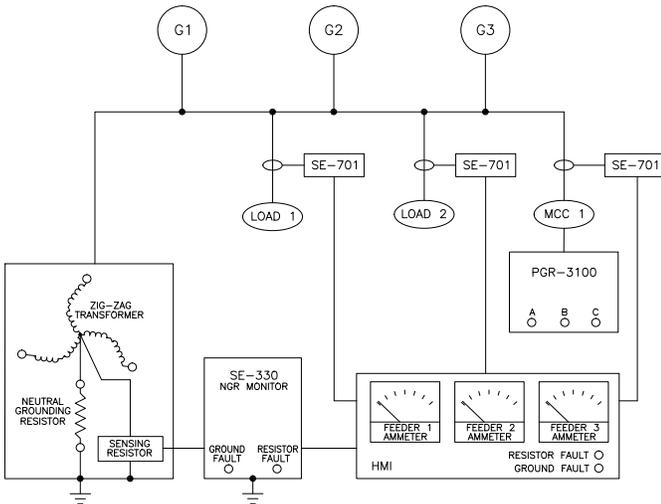


Figure 1. Simplified Schematic

Because each feeder is generally connected to several motor control centers (MCCs), each with multiple loads, the company installed a Littelfuse PGR-3100 Ground Fault Indication System (an updated version of the three-light system) on each MCC. (Fig 1)