AVOID DISASTER BY UPDATING YOUR RELAYING SYSTEM

A Four-Part Series

Is your utility at risk for events similar to those that have wreaked havoc in California due to utility-triggered wildfires? If your relaying system does not have the proper settings, you could be at risk.

Recently, Finley Engineering received a call from one of its clients, who explained that they had experienced a feeder fault. A wire was burning on the ground and the recloser did not operate at all. The cause of the problem was that the fault current level was not high enough to exceed the relay trip level. As a result, the recloser thought everything was fine, but the wire was still actually burning an orange hole in the ground! This could have been a disaster.

Ground Overcurrent Relaying Systems

With distribution systems, whether you use circuit reclosers or circuit breakers, they will have relays that monitor the distribution line current.

Ground overcurrent relays have a trip setting which can be set to be very sensitive, or not as sensitive, depending on the unique circumstances in place, such as how well balanced the circuit phases are, so that it will only operate during a fault condition.

There are three basic types of overcurrent relay settings, regardless of whether phase or ground current is being monitored:

1 - An instantaneous overcurrent setting is defined as having no intentional delay, that is, when the relay measures any current above its setting, it will trip the breaker or recloser. It does not matter how long or short of a time the current is above the trip level.

2 - A definite-time overcurrent setting is similar to the instantaneous setting, except that when the relay measures the current above its trip level, it will wait exactly a certain number of cycles or seconds (based on what has been programmed into the system) before it sends a message to the circuit breaker or recloser to trip. So, whether the current is 5 amps above or 50 amps above what is programmed, as long as the current remains above its trip level, it will wait for a specified number of cycles or seconds before sending a message to the breaker or recloser to trip.

3 - The third is based on a current-dependent curve. With this type, the more current there is, the less time it will take before it sends a signal to the recloser or breaker to trip. There are several curve "shapes" that can be applied, especially if a recloser is utilized.

High-Resistive Ground Faults

One of the perennial problems in distribution system protection is high-resistive ground faults. The potential severity of the problem depends a lot on the surface type that is underneath where the wires might fall. For example, if a wire breaks and falls on concrete, asphalt, or relatively dry soil, there is often not enough current for the relay, back at the recloser, to recognize that there is a problem.

So, the end of the wire can be on the ground sparking for an indefinite period of time, because there is a high resistance between it and the ground.

The integrity of the ground grid, at the substation where the recloser or breaker is located, plays a part in reducing ground resistance, but the greatest factor is how far away the broken wire is from the substation and what surface or soil conditions the broken wire is contacting.

While permanent faults like this can happen on occasion, it is generally accepted that, 75 to 80 percent of the time, faults on electrical systems are temporary - such as a squirrel, bird, or small limb coming in contact with a wire due to wind.

For this reason, most systems have either another electromechanical relay (or, more commonly these days, a microprocessor relay that provides multiple functions) that will trip the breaker or recloser, then signal it to reclose. This energizes the circuit again, and this may be all that is needed, because the squirrel, bird, or limb problem may no longer exist.

With a permanent fault, many systems will trip and then reclose three times in attempts to keep the power on. If it trips an additional time, the relay prevents the breaker or recloser from reclosing again, and the utility needs to intervene in order to restore power.

Fortunately, the incident Finley was informed about occurred in a recently tilled field and the soil wasn't completely dry. However, if it had been in a grassy field in really dry conditions, it would have sparked a huge fire.

So in this situation, the ground overcurrent was set too high and didn't recognize that there was a fault.

The kneejerk reaction to a situation like this could be to set the system very sensitive and very fast. However, if the phase currents aren't perfectly balanced with each other, a small amount of neutral current will flow to account for this asymmetry. If this current exceeds the relay's trip level, undesirable trips may occur. So, if you set the ground overcurrent too sensitive, it will alleviate the downed wire problem, but the system will almost constantly be tripping the breakers or reclosers.

That is, in non-fault conditions, it will send trip messages. For example, when you operate a three-phase switch to switch from one feeder to another, if all three phases of the switch don't operate exactly at the same time, a switching surge is generated and subsequently ground current flows, which could cause the breaker or recloser to trip.

In sum, if you operate at either end of the spectrum - settings too high or settings too low, the system will either trip almost all of the time, or almost never (even when it should).

Recommended Solution

Finley Engineering assisted this customer by providing relay settings, utilizing a low-set ground overcurrent relay and timers, that resulted in allowing the breaker, or recloser, to reclose for a fault (again keeping in mind that most faults are temporary), but still tripping the breaker if a high-resistance, low-current fault persists.

This solution can be accomplished somewhat easier with microprocessor relays compared to electro-mechanical relays.

Utilizing this type of system allows the feeder to stay on longer and reduce nuisance faults, but, for safety concerns, will trip the breaker back out again. This solution assists greatly in preventing the situation of having live wires laying on the ground undetected and creating the potential for catastrophic consequences.

The effectiveness of any type of ground overcurrent relaying is dependent on having a properly functioning substation ground grid, which will assist in providing a current path from wherever the fault is occurring back to the substation. If a high-resistive ground fault occurs on YOUR system, will YOUR breakers or reclosers trip?

If you have any questions about these solutions or want to discuss this topic further, please contact Mark Thatcher, 913-601-3518 .