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WIRED FOR

Part 3 of the series examines disturbances in the power supply grid that pedestal into your motorhome's 120-volt-AC system, potentially causing

The first two parts of this series explained how the RV alternating current (AC) electrical system differs from a residential electrical system; how an electrical system will respond under normal and irregular — and potentially dangerous — conditions; and the proper methods for testing the 120-volt-AC electric coming from the campground pedestal into the motorhome, as well as the electric being supplied by the generator and inverter.

The final installment will focus on electrical issues emanating from the power supply grid and what you can do to protect your motorhome's electrical components from being damaged by this "dirty" power.

All of us have heard stories about an air conditioner that hums to a stop and trips the breaker; a television monitor that's suddenly reduced to a thumbnail image; a microwave oven that quits in mid cycle right after a neighbor plugs his or her coach's shoreline into the campground pedestal; and reports of a lightning storm in the next county followed by the lights inside your coach suddenly becoming very bright. I could go on, but I think most of you get the idea.

RVers can encounter a multitude of electrical problems in virtually every corner of North America at any given time, in any season. These anomalies, collectively known as "power line problems," create frustrating dilemmas that we must be aware of and attempt to protect against. So, why should motorhomers be so concerned about power line issues? In recent years the advancement of motorhome electrical technology has resulted in many components in our coaches now being controlled by electronic boards and microprocessors. In addition, the use of computers, e-mail, and Web browsing have permeated the general RVing public. We are firmly entrenched in the electronic age of motorhome travel. Power line problems are no longer just a concern for the computer industry.

The AC shoreline, manifested at the campground pedestal, is the tethered lifeline for all things that operate on AC power and many items that are driven by DC power in the motorhome. But it also can be the pathway for a mystifying menace that can render useless many components found in the coach.

Let's begin by defining some of the more common electrical supply line conditions and the potential problems they can bring to the plugged-in motorhome.

STEADY-STATE VOLTAGE: Normal voltage planned for a system that stays constant for 10 seconds or longer. RV applications require 120 volts AC at a frequency of 60 hertz. This is provided as 30 amps or 50 amps (a second leg of 120 volts AC at 60 hertz for the latter) in most motorhomes.

TRANSIENT: Any short-term power disturbance on the power line. All of the following disturbances are transients by definition.

POWER FAILURE: A zero-voltage condition lasting for more than one cycle (1/60 of a second). From a power grid standpoint, it could happen on any of the three phases being delivered.

DROPOUT: A portion of the sine wave that has a lower value or is missing altogether, but only for a small portion of any given cycle.

BLACKOUT: A total power failure lasting from several seconds to many hours.

BROWNOUT: A planned and usually announced region-wide reduction of available steady-state voltage. This typically is associated with an impending expectation for heavy electrical consumption.

SAG: A cycle-to-cycle reduction of power line voltage of at least 10 percent of the average voltage for half of one cycle or longer. A sag in power may occur when your RVing neighbor first turns on his air conditioner. Sags are detrimental to electronically controlled devices such as microwave ovens, TVs, DVD players, and computers.

DIP: A short decrease in the nominal line voltage, but much quicker than a sag. This situation usually is visible only in an incandescent lightbulb.

IMPULSE: A very short disturbance of either polarity (up or down) superimposed on the AC sine wave that lasts between 0.5 and 100 microseconds. In-phase impulses that instantaneously increase the voltage are called spikes. Out-of-phase impulses that decrease the voltage are notches.

NOTCH: Similar to a dropout, though typically too fast to see. Notches can be up to several milliseconds in duration and usually come in pairs. For every notch there is usually an immediate spike following behind. A notch is simply an out-of-phase impulse.

SURGE: The opposite of a sag. Cycle-to-cycle increase in the voltage on any of the three phases above the normal voltage, but typically below 500 total volts. The lasting time of a surge is equal to its duration for the number of 60 hertz cycles that the power line disturbance is above normal.

SWELL: Basically a series of long-term surges that last from a few seconds to several minutes.

SPIKE: An in-phase, very brief rise in voltage ranging from 400 volts to well above 5,600 volts! Such a spike is superimposed on top of the AC sine wave and typically lasts for less than 1/1000 of a second (one millisecond). Any spike greater than 600 volts can be very damaging. Spikes contain high amounts of energy and are most detrimental to sensitive circuitry.

Transients can be classified as either oscillatory, varying consistently with the frequency, or they can be of the impulse variety.

Oscillatory transients usually are caused by one of the following:

- Lightning is the most common cause of spikes and surges that come from the power grid. Lightning strikes occur most often and are most severe during the summer months, though lightning has been observed during snowstorms. Lightning strikes can render sophisticated electronics in the motorhome useless or operationally intermittent. In either case, the result is usually costly. Surprisingly, lightning does not need to strike nearby to wreak havoc. A storm located miles away could induce spikes that can ultimately reach your campsite pedestal. Lightning between clouds that never directly strikes power lines or phone lines can create large magnetic fields that also can cause surges and spikes in onboard equipment.
- Utility grid switching is another oscillatory transient that can cause damage to your motorhome's electrical components. Your friendly power utility company can be responsible for creating spikes and surges simply by switching high-power distribution lines. Power lines also can pick up transients from the power company's operating equipment.
- Campground pedestal hookups also can be the source of oscillatory transients. Many RV campgrounds and destination sites were constructed some years ago when demand for current was not as prevalent as it is now. With today's larger RVs demanding more power to operate the modern conveniences we have come to expect, many older campgrounds are simply electrically undersized and outdated. When demand

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This three-part series examines the intricacies and safety issues that relate to a motorhome's 120-volt-AC electrical systems, and provides information about how to protect individuals and the motorhome when this electric source is being utilized.

PART 3

SAFETY

could be delivered through the campground damage to the electrical components in your RV.

is high for current in an overloaded campground, the power sags or dips drastically. Power line transformers on the grid try to compensate when low voltage is sensed by raising the delivered voltage. When the demand for power sufficiently loads that transformer, all is well; however, when the load is slight, the voltage could remain at dangerously high levels.

Impulse transients usually are caused by faulty (loose) wiring common in campground connections and within a motorhome; motor load switching; and improper grounding or bonding of power lines.

According to some electrical industry studies, voltage transients represent 12 to 15 percent of all AC power line problems, with only about 35 percent of those problems originating from the utility grid. As mentioned above, problems can originate from within the campground itself or inside your very own coach. In the campground or at a home base, transients can occur simply from a ground voltage differential between improperly bonded grounds during electrical faults. It is important to understand that given the state-of-the-art technology we now employ in motorhomes, all AC power lines, campground phone, cable TV, and data communication lines must be commonly grounded or bonded together to prevent transient voltages from entering sensitive equipment.

One study showed that surges and impulse spikes can occur as frequently as twice per hour in any typical location, some with peak values at 1,500 to 2,500 volts. In industrial applications, such as in a large campground, they can be more frequent and more severe with spikes as high as 5,600 volts as recorded during lightning storms. An earlier study by IBM in various locations across the United States revealed an average of 50.7 voltage spikes per month. Another study showed that many locales will experience approximately 25 power line disturbances per year, 87 percent of which will probably be sags below 96 volts AC.

The bottom line is that electrical disturbances, the so-called "power line problems," occur often, may be severe, and could cause substantial damage, which usually equates to expensive. What goes mostly unnoticed is the cumulative effect on sensitive equipment in the motorhome after enduring numerous spikes, surges, dips, notches, etc. The deterioration of delicate components from these transients may not surface until much later; all the while, the equipment performs at a substandard level until failure occurs. Unless, of course, the suggested AC inspections mentioned in the previous parts of this series become a habit.

What goes mostly unnoticed is the cumulative effect on sensitive equipment in the coach after enduring numerous spikes, surges, dips, notches, etc.

So, what can be done? One of the best solutions is to install a spike suppressor/surge protector in the motorhome. A number of suppliers now provide such protective devices for the RV industry. Surge protectors act like an electrical sponge of sorts, absorbing excess voltage, thereby protecting the entire coach. The surge protective device should include the ability to completely shut off the incoming power before damaging transients can reach sensitive onboard equipment. In addition, it should have the capability to monitor and detect both high-voltage and low-voltage conditions and to interrupt the incoming power until the current has returned to safer levels over a period of time.

Many surge protectors utilize a component called a metal oxide varistor (MOV) to protect against transient voltages. Quality devices usually have a minimum of three MOVs in the circuitry. More sophisticated protectors, such as might be used in the computer industry, utilize what is called sine wave tracking, which actually monitors the incoming AC signal and literally cuts off the top portion of the wave. It provides better protection for highly sensitive equipment. The most important aspect of any surge protection technology is determined by the "clamping voltage rating," also called the "let-through voltage rating." Devices with a lower clamping voltage rating provide better protection. Sine wave tracking protectors have a remarkably tight clamping voltage surrounding the incoming power line sine wave.

Some companies extol the joule rating of their surge protection device. A joule is a measurement of energy, and the rating indicates the amount of energy that a device is capable of absorbing. The total number of MOVs in a device primarily determines its joule rating. Unfortunately, there is no standard for measuring the joule rating of surge suppressors, but generally those with a higher rating are considered better. It is thought by many in the surge protection business that the joule rating of a surge suppressor is less important than the "let-through voltage" rating. Underwriters Laboratories (UL) has developed a minimum standard for spike suppressors. The surge protector you choose to install in your motorhome should meet or exceed the requirements of UL 1449.

You are encouraged to investigate the feasibility of adding transient voltage protection to your electrical system. If you truly value the electrical equipment in your motorhome and are well aware of the consequences, it can be considered inexpensive insurance at the very least.

And remember, RVing is more than a hobby; it's a lifestyle! **FMC**