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ELECTRICAL "SURGES," and [Cautions Hand-out](#) for Rallies

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This information is the result of a computer search through more than a thousand references. Included were—references from: Bell Labs, IBM, DOE, National Documentation Library, IEEE (Institute of Electrical and Electronics Engineers), EPRI (Electric Power Research Institute), Electrotek Concepts Inc., Z-World Engineering, Kalgo Electronics Inc., Rose Business Systems, a variety of text books and much more.

"SURGES"

"Surges" is in quotes because I'm a bit skeptical of what some people report as surges. The most common is something like this note, "We were at a rally (with everybody connected by extension cords to some minimal electric source) and there was a 'surge' and we lost all our 'stuff' in the rig, etc."

The key question is: Were they the only ones? If it was a genuine electrical surge, then it should have affected everybody else too. Some would also have lost everything (or at least some things). Others, with "Surge Protectors" might only have lost the surge protector. But, if the people above were the only ones affected, it's likely they weren't the victims of a surge at all, but of some electrical problem in their own rig or the specific receptacle they were using. This is not a surge.

A "surge," as it's usually defined, is just that—a huge jolt of electrical energy that somehow comes on the power line. It may be from a lightning strike or it may come from any number of problems in the power source. Both of these causes are most unusual. Most of us have encountered a serious nearby lightning strike only once or twice. Power company surges are even more uncommon. More common with power companies is a sudden lack of power (brownout or zero power) which can also do damage, but usually doesn't do anything as severe as a real surge—unless you're using a computer at the time.

But, in the RV world, "locally produced" or "self produced" power "surges"

are very common--and avoidable if people pay attention to what they're doing. When you're sharing electricity (as at a rally) any of the RVs you're sharing electricity with could have an electrical problem that is, in turn, "shared" by everybody else. What kind of problem? Many. They might affect just the "guilty" RV (which, luckily, is the usual case) but can also affect others. A few examples:

- Suppose someone has a catastrophic short between hot and neutral or ground? His own main breaker should kick off (but, sometimes, not) before the equivalent of a surge has damaged his RV (and can be routed to other RVs on the line as well).
- Suppose some moron, without proper equipment, turns on his generator while still tied into commercial power? 120 volt AC generator power, totally out of phase when generator output is suddenly attached to commercial power, will produce the same effect as a major surge. There are supposed to be safety measures in an RV to prevent this like:

Manual plug-ins so generator can't be on-line at the same time as commercial power (or an inverter).

Manual transfer switches that accomplish the same thing.

Electronic-relay transfer switches (ditto).

But, we have no idea what any given RVer might have wired up on his own. We have no idea what some manufacturer might have done. We have no idea when an electronic transfer switch might decide to "seize up" with both power sources being connected together (this last defect, not uncommon, can set your rig on fire in moments).

Suppose some clumsy person or errant driver gets hung up in an RV's power cable? Imagine how screwed up things could get. (Especially if he tries to help by putting things back together before anyone notices.) First, there's no power. Then, maybe a surge. Then, who knows what?

And more: A great number of RVs are miswired--usually at the factory but sometimes when the owner fools around. The 120 volt AC wires in a house are wired differently than in an RV. In a "house" the neutral/white wires are bonded to a common bar. The ground (bare/green) wires to another bar. Both bars are connected by being screwed into the metal box

itself (thus a common ground). In an RV it's essential that the neutral and ground not be wired together this way (and the instructions that come with the box—called a load center—cover this and they even provide an insulator to make sure it doesn't happen if you don't want it to). In an RV the neutral wires and ground wires must NOT be connected together. The results of bonding neutral and ground together are serious, but not usually noticed by the casual RoVer: A slight shock when standing in water and touching metal RV frame or siding. A dog, chained to a metal bumper, starts bouncing up and down and provides amusement. But, this condition can, over time, result in all that's necessary for a "locally produced" or "self induced" surge that will wipe out "all your stuff" (and maybe you).

Still, genuine power surges can and do occur. The most common from faulty power company transformers (or when someone runs into a power pole and sends the whole thing crashing to the ground). "Surge Protectors" can prevent some or all of the damage. There are various ways to design surge protectors, some more efficient than others. Following is a **very** simplified description of two forms of surge protection (with no technical terms) that are practical for RVs. (A full description, with all the terms and electrical measurements, would take hundreds of pages.)

SHUNT-MODE SURGE PROTECTORS--The essential ingredients of most common surge protectors are simple, cheap electronic components called MOVs (Metal Oxide Varistors) connected to the main power circuit. Under a surge, the MOVs "sacrifice" themselves, break the connection and prevent (most of) the surge from progressing any further. You can buy MOVs at any electronic store, find a surge protector diagram in any hobby magazine and build your own. I don't recommend this if you don't know what you're doing. Also, MOVs alone provide only the most basic (crude) form of "shunt" surge protection. There are much more sophisticated surge protectors, based on MOVs, but with an array of other active devices included. "Shunt" protectors, shunt the surge away from the powered lines and to ground. In doing so, the ground line carries the surge (not too swell, but usually effective in preventing a catastrophe). Also, MOVs are gradually degraded by "little jolts" (not just giant surges) and eventually are incapable of protecting anything. There is no way to forecast when this will happen.

SERIES-MODE SURGE PROTECTORS--are superior to MOV-based

protectors in many ways. An inductor (coil) is the key surge protector (plus other goodies). There is no contamination of the ground circuit, minimal disturbance on the neutral circuit and only a very low let-through voltage. The coil can be quite large in a "house" electrical system of over 400 amps capacity (unless a protector is installed in each circuit--bulky and expensive). In an RV, where maximum capacity is 30 to 50 amps, series-mode protectors are practical though still a bit bulky.

UL STANDARDS--Underwriters Laboratories Standard 1449 for Transient Voltage Surge Protectors (TVSS) and a UL follow-on to 1449 with more strict standards are your only assurance that a surge protector is really a surge protector and not just a receptacle with who-knows-what inside of it. Insist on the UL 1449 standard (it should be printed on the box). Further, look for a UL listing of three ratings: Hot-neutral, Hot-Ground, Neutral-Ground (the three circuit pairs that need to be protected) not just one (Hot-Ground) as found in el-cheapo protectors. The UL Standard does not mean your surge protector is terrific, just that it meets minimum standards. Manufacturers or dealers should be able to show you specific test results for the various tests conducted and how their protector meets (or far better beats) the minimum standard. For example: UL 1449 might allow a pass-through (brief) of 500 volts at surges in the thousands of volts and amps. A really good surge protector should allow no more than 300 volts pass through or less. "Joules" are another consideration. Simple rule of thumb -- the more the better.

Available Commercial, Whole-RV Surge Protectors--Many surge protectors are available. From simple single circuit types (\$5-12) that protect a single appliance to massive things that will protect a whole house (big\$). Most RVers are interested in a surge protector that will protect the entire RV. Fortunately, since we're only interested in a 30-50 amp capacity (rather than 400 amps as in a house), such protectors are reasonably priced (not cheap though).

- Readily available in almost any RV store is one for about \$80. Its **good points**: Inexpensive, has appropriate RV-style cable connections, includes a built-in GFI (Ground Fault Interrupter) that will shut it off if there's a "short" in the circuit. **Bad points**: Some of these are sealed and cannot be repaired which is just what you *don't* need in a surge protector that "sacrifices" some of its components under surge. The basic components

are cheap, but if you can't get to them and replace them, then, instead of spending about \$5 for parts, you'll replace the whole magilla for \$80.

- Better surge protectors in the same outdoor style or for connection in the RV at the electric panel (keeps people from stealing them) can be bought from several companies (and will cost more). At least two advertise in many RV publications. Some of these sophisticated surge protectors reset themselves or are manually resettable, some are repairable and some models include extras, such as high and low voltage cutoffs and a feature to protect your system against generator spikes. **CAUTION:** Some of these whole-house RV oriented surge protectors can make a very annoying "buzzing" noise. Some do not work well with inverters. Quiz the manufacturer first! Don't just buy one at Camping World, because they won't have the answers to tricky questions.

CAUTION: Many surge protector manufacturers provide only the skimpiest description of the protector capacity and test results. One reason might be that the technical specifications are too difficult for the typical consumer to understand, so why bother? They should, though, respond to your questions. One way to quiz them is to ask, "Why their brand is the best?" and write down the answers so you can compare them against the competition's answers. They should be glad to tell you what theirs does and why it's the best. If they make vague remarks or, worse, don't answer the question, but instead start running down the competition, I suggest you look elsewhere. There's nothing wrong in pointing out where the competition is lacking, AS LONG AS they point out where theirs is better.

In-The-House Protectors: Some people think they can economize by protecting only critical in-house circuits (TV, etc.,) with cheap surge protectors. This is a mistake because a surge can do far more damage to electrical wiring, reefer and things you might not consider (mainly, anything with a circuit board in it). Some people, with computers, fancy stereo systems and the like, protect the whole house and also protect inside circuits. (Highly recommended.) Single circuit protectors (in addition to a whole RV protector) give a bit more added insurance. For computer and video/music systems, protectors with multiple outlets only cost \$20+ (but aren't really very good). Much better multiple-outlet strips with "real" surge protectors inside include as options 'phone line and co-ax cable protection as well as filters to keep power line noise and RFI (radio

frequency interference) from annoying you and can be found in magazine ads/stores for about \$75. **American Power Conversion (APC)** brand has some very good ones.

Back UPS (Uninterruptable Power Supply): Computer users, in a house, will want a back-up, uninterruptable power supply. The good ones include a surge protector and lots more. RV computer users might want the same. However, if you have an inverter, and if your computer is compatible with it, you already have a back up. But instead of the short (5 to 20 minutes) backup of a household unit--that just gives you time to shut the thing down without damage, you have your whole RV battery bank working! You never have to worry about disconnects or surges (as long as you have a surge protector to protect the battery charger itself).

Polarity Checker: There's one more critical item you need. It's cheap, too. It will protect you from hooking up to unsafe AC power in the first place, thus avoiding most (but not all) of the RV park-induced/self-induced /sharing-neighbor-induced "surges." It's a "polarity checker" that you can buy in any hardware store for \$7. Plug it in before plugging in the RV and coded lights will tell you if the circuit is safe. Don't ever plug into AC power without checking this first. You don't need to because you always go back to the same place? How do you know what happened while you were gone?

What I use: First, a good solar electric system so I almost never use commercial power in the first place. For those occasions when I do use commercial power: A surge protector for the whole RV. Additional single circuit protectors at battery charger, inverter with additional battery charger (not needed at other inverter with no battery charger), refrigerator and microwave oven. Surge protector with multiple outlets and filters for TV, stereo, computer. (All these last, extra-sensitive items are always powered by an inverter, even when on commercial power. By doing so I have extra surge protection and automatic back up--no problem if my AC power is disconnected.)

Line Conditioners, Auto Transformers and such:

These devices use a transformer and other internal components to keep voltage at a safe setting and, depending on how constructed, may also

raise low voltages to an acceptable level. **"Hughes Autoformer"** brand is of primary interest to RoVers. Units made for use with smaller electronic devices (like computers) won't handle the whole RV system. The "Hughes" is one of those "Things That Work." (Which means it's pretty damn good.) And it works well IF you understand what it is intended to do.

It is NOT (necessarily) a "surge protector" -- though some models do have an adequate surge protector built in.

It does NOT "clamp" higher than normal voltages. Whether you have the manual or automatic model, YOU will still have to keep an eye on a voltage meter so voltage doesn't get too high.

It is NOT a "polarity" PROTECTOR -- though some models have a polarity "checker" built in to warn you that the AC source has improper polarity and you shouldn't use it.

It DOES detect low voltages and then increases that low voltage to about 118 volts AC. When it senses that its incoming voltage is at or above 116 volts AC, it simply stops boosting the earlier low voltage and just allows the higher voltage to pass through. It's not cheap, BUT many RoVers find it well worth the cost since prolonged low voltage can destroy some appliances (especially air conditioners.)

The Autotransformer is well made and rugged. Its applicable components are UL Listed. It's weather resistant, (but not totally weatherproof and can't be laid in a mud puddle). It weighs about 22 pounds. A bracket/handle allows it to be easily carried and it can be "hung" from the typical campground "power post" with a bungee cord or similar. A simple "U-shaped" foot on the bottom allows it to be placed in an upright position on a box or somesuch (if not hung). This bracket is also a convenient place to "chain and padlock" the unit to resist theft.

If used with a "whole RV" surge protector, you would first plug the surge protector into the commercial AC power source, then plug the Autotransformer into the surge protector, then plug the RV into the Autotransformer. The above will work, but will leave two expensive units out where they can be stolen or otherwise abused. The units can be installed in an RV compartment. In this case, the main RV AC power cord plugs into commercial AC in the usual way. At the RV, the main AC cord is disconnected from its usual termination point in the RV's AC load center

and goes to the surge protector. From the surge protector it goes to the Autotransformer. From the Autotransformer it goes to the original AC loadcenter and on to feed the RV in the normal way. It sounds more complicated than it is.

IF you frequently park in campgrounds, you may be very-well served by an Autotransformer. Some RV parks are just poorly wired and frequently have low voltage conditions. Even well-designed RV parks can experience low voltage when "everybody" decides to do something -- like turn on coffee makers and hair dryers each morning; or air conditioners when it gets warm.

At RV rallies, when many RVs are on a rather flimsy, temporary AC supply, an Autotransformer can keep you out of trouble. BUT, at a rally, where people are sharing a minimal AC line, this does NOT mean you should run an energy hog like an air conditioner -- you'll just "hog" all the juice and make things worse for your fellow campers.

Below are explanations, tips, do's and dont's and the like on the effects of high an low voltage as compared to genuine surges and other catastrophes. This originally came about for use at "Escapades." The [Cautions Hand-Out](#) is the sheet handed to people at Escapades and similar events. You might want to make copies to hand out at your rallies.

THE EFFECTS OF HIGH AND LOW VOLTAGE

An actual electric surge (lighting strike or power company catastrophe) is extremely unusual--but possible--and you should always use a surge protector. The vast majority of high voltage incidents are not due to surges, but are "surge-like" conditions due to RVer carelessness and accidents that damage the electric system (yours and those on the same line). Be careful. Here are some precautions to avoid creating a problem when sharing electricity with others:

- If you've been experiencing electrical problems, don't just plug into extension cords being used by others when at a rally or similar power-sharing location. If you don't know what you're doing you can screw up other people.

- Always check the polarity on an extension cord before plugging in. Just as you can screw up other people, they can screw you up too if they don't know what they're doing.
- When sharing power, don't ever run your generator without first disconnecting from commercial power. A faulty generator (or a mis-wired generator) can screw everybody up.
- Don't ever unplug an RV so you can insert another power "splitter" and add yourself to the shared power. Find out where the line goes first, and get permission. You have no idea what sensitive electric equipment your neighbor might have running until you ask. (The same thing goes for shared water lines.)
- If you inadvertently disconnect someone from power, don't just plug them back in. Follow the line and tell them what you've done. Better that someone be slightly irritated and call you a dumb bozo than that you should screw them up even worse than you already have.

GENUINE HIGH VOLTAGE SURGE

What is it? Lightning and failed power company equipment. Catastrophic in nature.

What can you do? Use a good surge protector. Unplug your RV from commercial power when storms threaten. If you see a "crackling/arcing" power transformer, unplug. If someone drives a vehicle into a power pole, unplug.

ARTIFICIAL SURGE

What is it? Similar in effect to the high voltage surge above, but caused by someone (you?) who interferes with the power system. Examples: Tearing power connections apart with a vehicle or tripping over them. Running a generator that isn't properly isolated from the commercial power system (Do NOT ever run a generator without disconnecting from commercial power when you're "sharing" power with others. Do NOT trust an automatic transfer switch to protect your RV or your neighbors.) Running a faulty appliance in your RV that "melts down." Plugging in faulty power adapters. All these may affect your neighbors on the same system.

What can you do? Pay attention to what you're doing. Artificial surges are the most common cause of severe damage (the kind that can wipe out your whole RV -- and your neighbor's). **DON'T BURN UP YOUR NEIGHBOR'S RV!**

HIGHER THAN NORMAL VOLTAGE

What is it? Not a surge, but voltage in excess of 130VAC for an extended period.

What will it do? Burn out or cause premature failure of lights, refrigerator heating element, sensitive electronics in any number of appliances (including things like automatic coffee makers with timers).

What can you do? Every RVer should have a simple, cheap voltage monitor plugged into one of the easily-seen AC receptacles in their RV. If you don't have one, connect your multimeter.

LOWER THAN NORMAL VOLTAGE

What is it? The most common cause of damage to electrical items in an RV. It is any sustained voltage of 104VAC or less. Common at RV gatherings as well as at campgrounds with insufficient power to sites.

What will it do?

Electric Motors Low Voltage means higher amperage. That means more heat, slower running and early failure. **LV** also means that motors with a starting switch (see Air Conditioners below) like washing machines may not reach starter winding cutout speed and this will result in motor damage. Some motors, however, will just run slow and not be damaged. Do you want to risk yours to find out?

Air Conditioners **LV** = Motors die early as above. Also, compressors (constant horse power loads) will be severely stressed and burn out.

Fluorescent **LV** = Constant cycling of circuit board and ballast. That

- Lamps** means premature failure.
- TV/VCR/etc.** LV = Heat = premature failure of components. (And see Power Supplies below.)
- Refrigerator** LV = Relays fail to operate properly; unit goes into search mode from 120VAC to LP to 12VDC constantly and thoroughly confuses circuit board that, in consequence, fails.
- Furnace & Water Heater** LV = Slow fan, which = too much heat in furnace enclosure, which destroys circuit board. Water heaters with auto ignition have circuit board that may fail or not operate properly.
- Microwave Oven** LV = Fan runs slow. Fan cools a magnetron (the cooking element). Hot magnetrons die if run too long in this condition.
- Power Supplies** LV = Some power supplies will run too hot (switching power supplies); some just won't regulate properly (linear type). Either, if not running properly, are components of and may damage, computer equipment, TVs, VCRs and the like.
- What can you do?** Monitor your electrical system for Low Voltage just as described above for High Voltage. Use a "Hughes Autoformer" if you want to protect your appliances. When at an RV gathering, like a rally, be considerate. Don't be an energy hog.

Some items won't necessarily be damaged by low voltage. They just won't work or won't work well. Examples: Incandescent lamps, heaters, clocks, non-automatic coffee makers.

Some appliances are known to fail, even when turned off, and create disasters. Among these are toasters, automatic coffee makers and other heating items. These should not be plugged in when not in use (in your RV or at home).

The concluding Electrical Surges [Cautions Hand-Out...](#)

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