# Open Neutral

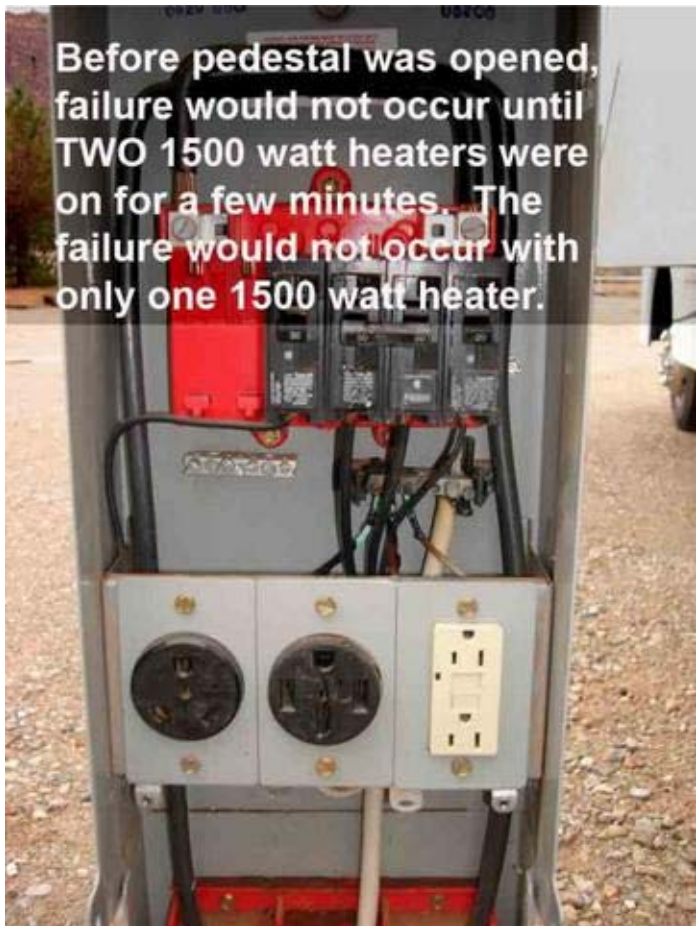
*The following was copied with the authors (Daryl Daughters) permission from the Newmarowners Yahoo Group Read why it is so important to check the Campground service before you plug in. Even with checking for Voltage, correct circuit wiring and having a Surge Protector things can go wrong.*

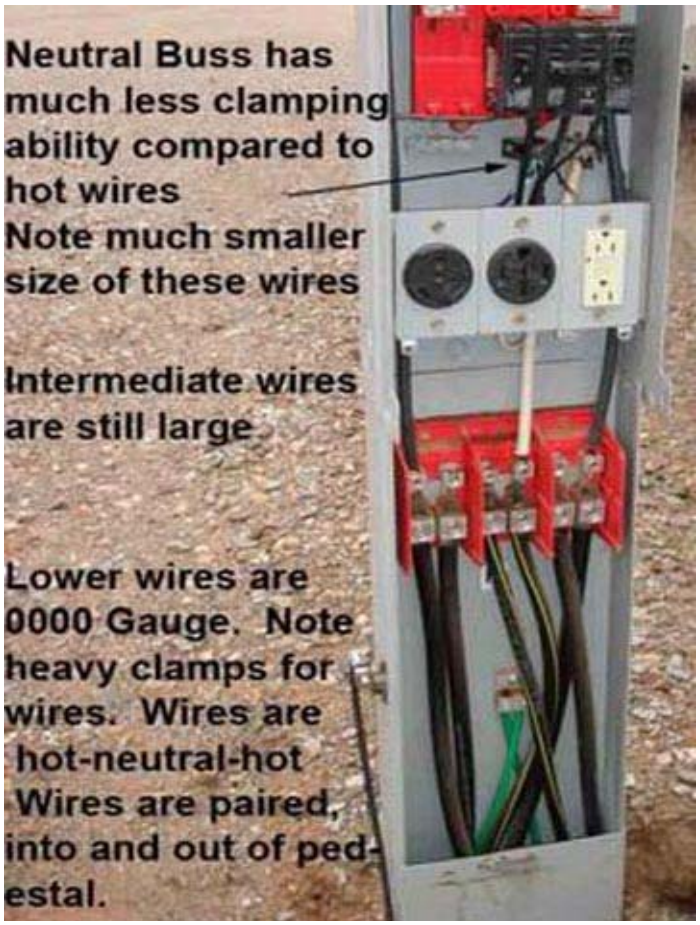
We've had discussions in the past about the dangers of an open neutral when using 50-amp power. When the neutral line opens, there is no zero-volt reference for the two hot 50-amp lines, and it's possible to have 240 volts applied to half the stuff in your RV. The campground owner where we are staying knows that I'm "into" electricity, and she came to me for help after another camper had an electrical fire. He had smoke coming out of his converter (makes 12 VDC from 120 VDC) and his microwave. He had disconnected power and the campground owner had shut off electricity in that part of the campground.

I talked to the camper, and he said that the microwave started smoking shortly after he turned on the electric heating element for his water heater. I turned the power back on for that part of the campground and checked the power pedestal, and the voltages were fine. I suspected an open neutral problem because the microwave smoking was related to turning on the water heater heating element, and there should be only a very minor correlation. I used my test adapter, which plugs into a 50-amp outlet and has two regular outlets, each connected to one of the hot lines. I tested the voltage with a 1500 watt heater, and the voltages remained good. We then turned off all the breakers in the motorhome except for two circuits where we could be sure that only outlets that we could control would receive power.
We applied power to the motorhome and plugged a heater in while measuring the voltage between neutral and ground on one of the un-powered motorhome outlets, We read about two volts. I also had a voltmeter connected to the power pedestal so I could isolate where the open neutral was if we could get it to occur, and between neutral and ground I also read about 2 volts. After several minutes without a failure we added a second heater inside the motorhome. About a minute or two later the failure occurred, and there was 80 volts between neutral and ground at the un-powered outlet in the motorhome, and about the same at the power pedestal. This means that with the two heaters on, anything on the other hot line would be getting about 200 volts.

Since the voltage was bad at the power pedestal, the problem was not with the motorhome.

We then talked to the campground owner and got permission to open the power pedestal. All the wires going to the neutral buss were discolored, and the insulation had either burned or melted.




The power pedestal is less than a year old. It was made by Milbank, which is probably the most common manufacturer of power pedestals. As you can see from the photos, the hot and neutral lines coming into the pedestal are large (0000 gauge), and the clamps for these wires are also very large. There are secondary large wires that carry the hot lines to the circuit breakers, and these clamps are also large. The problem is that the neutral buss is way too small, and it's not thick enough to be able to apply sufficient torque to the neutral wires without stripping the threads. This is what leads to so many open neutral failures.

Another important thing here is that the failure did not occur with only one 1500 watt heater -- it took two 1500 watt heaters and some time. This means that any electrical protection device would not have caught the failure before power was applied to the motorhome because they don't apply any load. My test adapter that lets me test voltage using a hair dryer for a load is also insufficient. I'm going to need to plug in as many hair dryers or heaters as needed to at least equal the current I expect to draw with the motorhome, and then leave the load on for a few minutes to make sure enough heating of the pedestal connections has occurred.

An electrical protection device would have cut power off after the failure had occurred, which possibly could have reduced the failures in the motorhome if the failures were over heating due to the higher voltage, and not the higher voltage immediately destroying solid state devices. Power supplies for electronic equipment might be able to last long enough to survive if the power was cut fast enough to prevent over heating.

**The obvious question is what can we do to protect ourselves. If you only plug into 30-amp power you're significantly safer because an open neutral will almost always only result in lower voltage.** Someone previously suggested plugging into two 30-amp adapters, hoping that they would both be the same phase. The campground we're in is wired correctly, with the hot lines reversed at every other pedestal. Doing that somewhat equalizes the current from campers that use 30 amp power. It also means that adjacent 30-amp outlets are wired out-of-phase, and an open neutral could result in 240 volts being applied to half your motorhome. You'd have a better chance of not losing the neutral line if your adapter to allow you to connect to two 30-amp outlets uses both neutrals, but you could still get hit if your motorhome neutral opens, or the campground neutral opens before the power pedestals. Making an adapter that only uses one leg of the 50-amp power would save you from open neutrals that are in your pedestal or your motorhome (but not before your pedestal). Doing this would also increase the current in the neutral line, which likely would induce more neutral line failures. Normally only the difference in current between the two hot lines winds up flowing in the neutral line (i.e. if you're drawing 30 amps on one hot line and 20 in the other, the neutral line would be carrying 10 amps).

I think the best way is to test the outlet with more current than you are going to draw for at least several minutes. Having an electrical protection system would add protection for things that get destroyed from over heating, but they also have a relatively high failure rate, so you might want one that plugs in rather than being hard-wired.

-- *Daryl Daughters, 2002 MADP, Fulltiming for over 5 years, and still having lots of fun*

## Additional comments and Q & A concerning the above discussion.

Q: *Would putting a Hughes Auto former in line prevent this from happening as it's supposed to monitor high voltage as well as low voltage and act accordingly.*

A: I don't think so because the Hughes Autoformer voltage correction range is much less than what happens when the neutral opens.

This open neutral issue is a serious potential problem every time we connect to a 50-amp outlet. In this case I was able to prove that the damage done to the camper's motorhome was caused by the power pedestal, and the campground owner is going to have to pay for the damages, and at this point, the owner does plan to pay for the damages or get the campground's insurance company to pay for the damages, or recover the cost from Milbank, the company that made the power pedestal. I don't think Milbank is going to pay because they have a sticker on the inside of the panel door that lists lots of information about the pedestal, and also says:

"Shipping tends to loosen bolted connections. Check and tighten all hardware before energizing unit"

That throws the responsibility back to the campground owner, or the electrician who installed the pedestal less than a year ago. The campground owner is a nice person, and I expect the campground will either absorb the cost or get their insurance company to pay for the repairs. I'm guessing there will be a lot of finger pointing today.

The camper that had the problems assumed that the failures in his motorhome was caused by a power surge. Without someone with the knowledge, tools, and permission to investigate the issue, the camper likely would have had to absorb the repair costs. He didn't even think it was the campground that caused the problem.

Q: *Why is the 30 amp circuit immune from high voltage when the neutral fails?*

A: It's not totally immune, it depends on where the neutral physically opens. Below is referring to 30 amp or 20 amp power, NOT 50-amp power.

If the open neutral occurs BEFORE your pedestal, and there are other RV's connected to that same neutral line AFTER your pedestal, AND they are using the other hot line phase, then you could get excessive voltage. This is not very likely to happen for a couple of reasons. First, typically the power and neutral wires going into your pedestal are large, and because of this, the electrical clamp mechanism for these in the pedestal are large, and are usually trouble free. This makes an open neutral before your pedestal unlikely (it could happen if someone is digging a hole with a backhoe and they cut the neutral line but not the hot lines). Second, many campgrounds

have only 30 amp power, and it's likely that only one hot phase is being used on the neutral line you're using. If there is only one hot phase being used with your neutral, then the voltage can only drop, not increase.

If an open neutral occurs AFTER your pedestal it won't affect your pedestal (you still have a good neutral).

If the open neutral occurs IN your pedestal, you're safe because you're then only getting one hot line, and there's not a return path for the electricity, so there would be no current flow and no damage.

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*Q: We still have a 30A MH and I am beginning to think I want to stay with 30A*

A: 30-amp power is definitely safer. If you have a 50 amp motorhome you can use an adapter that lets you connect to 30 amp. Some people use 30 amp all the time unless they know they're going to need more power.

You could make an adapter that connects to only one side of a 50-amp outlet, but feeds both sides of your power cord. That would give you 50 amps instead of the 100 amps you actually get with full 50-amp power (because normal RV 50-amp power is two 50-amp lines). This should be about as safe as 30 amp and you get 20 additional amps.
It's safer because you are only receiving power from one of the two phases, and if the neutral in the pedestal opens, all that will happen is that you will lose voltage, which rarely would cause a problem.
Jim Epting on the *Newmar Owners Yahoo Group* came up with this idea.

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Q*: Is this a good place for a progressive or other EMS unit that would control spikes?*

A: The open neutral failure is not a spike issue, and the varistors they use are typically 600 volt. The open neutral only creates 240 volts.

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*Q: In other words there is NO protection to prevent this from happening, other then doing the pre hook-up test you perform? Correct?*

A: The pre hook-up test with a heavy load is the best way.

I've been against the Electrical Management Systems (EMS) because they don't test the pedestal under a load, and they can't cut the power fast enough to protect electronic equipment, but I'm beginning to believe that they may be useful. This open neutral was caused by a bad connection at the neutral buss in the pedestal, and when it failed, it first partially failed before it failed enough to burn stuff up. A well-designed EMS might be able to cut power fast enough to save some items from failing. The camper in this situation started having strange things happening with his power, like a fan ran much faster than normal for a few seconds, almost 24 hours before there was the major failures. An EMS should cut the power when this happened, but then they normally automatically re-apply the power when the voltage is good, which in this case was whenever there wasn't heavy current being drawn. You'd need to realize that power was cut and immediately turn off the main breaker until you figure out why power was cut, but how are you going to do this? It could have been a minor power surge or voltage drop that was harmless and there's no easy way to tell if it was an open neutral problem, which is always very serious.

We have a 4.5 cubic foot electric refrigerator, and because of this we leave our 2000 watt inverter on standby all the time. We occasionally lose power and never realize that we lost power until we see that one of the electric clocks is ahead of where it should be (clocks often run faster on inverter power). I don't think the EMS's set off any type of alarm when they decide to drop power (anyone know for sure?).

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*Q: By the way do you have an EE background? Sounds like you do*

A: Yes, I have a degree in Electrical and Electronic Engineering (EEE).
I worked 25 years for General Dynamics designing and testing mostly missiles, followed by 8 years at a small microwave equipment company.

-- Daryl Daughters

**This should induce all of us to check the Service including checking it under load.**