RV TECHNICIAN

PUBLISHED BY THE RVDA EDUCATION FOUNDATION'S

RV Learning Center
Developing Top Performers®

December/January 2011

CAUTION: HOT!

Avoiding Hot-Skin Condition

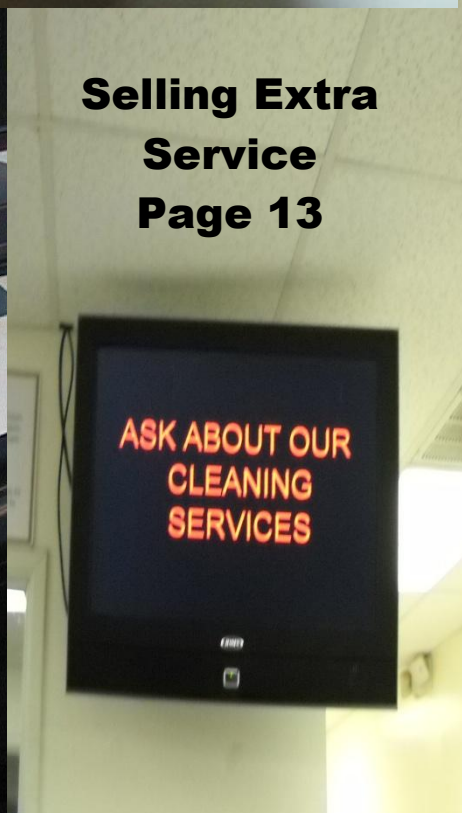
Page 5

Solar Panel Installation

Page 15

Selling Extra Service

Page 13



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ELECTRICAL

GENERATORS

WALK-AROUNDS

SOLAR PANELS

TOP THIS!

DEPARTMENTS

Testing for hot skin
page 5

Generator troubleshooting
page 11

Upselling service
page 13

Solar panel installation
page 15

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Can You Top This??

This edition of *RV Technician* focuses on electrical issues and begins with a story about testing RVs for hot-skin condition ("Caution: Look Before Touching!"). Caused by factors such as owner modifications and poor maintenance, this phenomenon can result in potentially life-threatening shocks to technicians unaware that they're working on a "hot" RV.

The story is written by a new contributor, Mike Sokol, who has worked as an electrical engineer in the recording industry. As a stage technician, Sokol witnessed many people accidently shocked by their instruments and equipment, and he became convinced of the need for better safety information about working with electricity. He created a website, noshockzone.org, that offers up info and demonstrations on the principles of electricity and how to work with it safely. Recently, he added a section geared to RV owners. Sokol hopes to bring his safety crusade to RV dealerships in the form of seminars for both owners and techs.

Steve Savage's story, "Wish I'd Listened To My Mother," is also about electricity—an intermittent power problem that he encountered recently in a coach. At least, on the surface it seemed to be an electrical issue. The coach's main circuit breakers would trip at odd intervals, and replacing them three times didn't solve the problem. The underlying cause—which, incidentally, the coach's owner finally stumbled upon—led Savage to realize that sometimes electrical issues aren't about electricity.

Savage's story is actually the first in a new series called "Top This!" Consider this series a challenge to you, the readers, to send in the most unusual and forehead-slapping repairs that ever darkened your dealership. Tell us about stubborn situations that stumped you, kept you awake at night, and perhaps still haunt you. What were the strangest symptoms you ever faced? How did you solve them? Share your triumphs—and failures—with *RV Technician* by e-mailing me at mashreve@rvda.org. Be sure to read the spring issue for another "Top This!" called "Your Goat is in My Truck."

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Avoiding Hot-Skin Shocks

By Mike Sokol

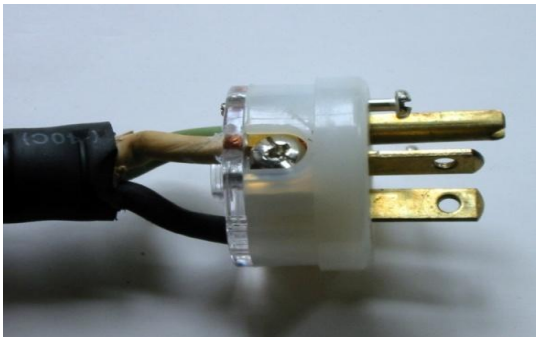
While the typical RV has been designed and built with all applicable electrical safety codes in mind, once the vehicle leaves the factory, numerous factors can combine to compromise an RV's electrical safety.

These factors range from owners' modifications of the RV electrical systems to improperly wired extension cords to poor connector maintenance to road damage from water leaks and vibration. And while these electrical failures sometimes show up as spectacular fires and melted wires, more often they create something called a hot-skin condition. This cross-connection of the wiring system can cause the entire body of the RV and all its appliances to become charged with as little as a volt or two of high-resistance current, all the way up to a 120 volts with 30 to 50 amps of current capability. While this hot-skin condition may not damage the RV's electrical system or appliances, it's certainly dangerous for anyone touching the body of the RV and the ground at the same time. It only takes 30 volts of AC voltage to stop your heart, so any shock you feel has to be considered potentially dangerous. This article is designed to help you identify an RV with a hot skin condition before you or anyone else in your shop touches it.

RV power distribution

What makes an RV more dangerous than a stationary house's wiring is that an RV is plugged into a different power receptacle every time it visits a campsite. And if the power plug becomes damaged through too much current draw or someone running over the plug with a tire, RV owners will sometimes take it upon themselves to make a trip to Home Depot and replace the plug on their own. So the very first thing to look for is an aftermarket plug on the RV's shore power line. If it's obviously not factory, then do a quick visual on the wiring color codes. This first article will cover 120-volt systems, but 120/240-volt electrical systems should be checked as well.

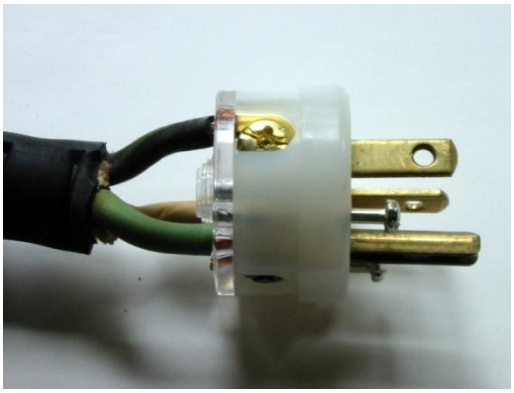
In most cases, modern RVs use 30-amp/120-volt or even 50-amp/120-240-volt shore power connections, and should use a molded, outdoor plug. But never underestimate the average RV owner who may first try to fix his broken or burned up power plug with electrical tape and a prayer. This is especially problematic given the availability of "dog bone" plug adapters that allow the owner to plug into alternate power sources, often with disregard for current safety limits. So whenever you see an aftermarket plug or electrical tape around a connector or wire, your "spidey sense" should be alerted and make you peel back the duct tape or take a peek inside the connector BEFORE you plug into power. First, let's review the basics of extension cord construction. In the first picture below, you can see that the white “neutral” wire is connected under the silver-colored screw in



Picture 1: white neutral wire under silver screw

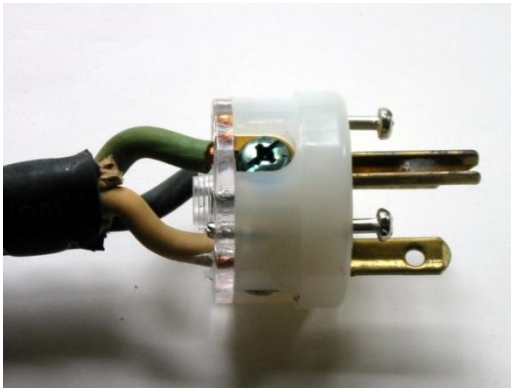
the plug. Also note that there are no strands of wire sticking out from under the screw, which would be a sure sign of an amateur job.

Next, check that the black "hot" wire is properly tightened under the brass screw, as seen below.



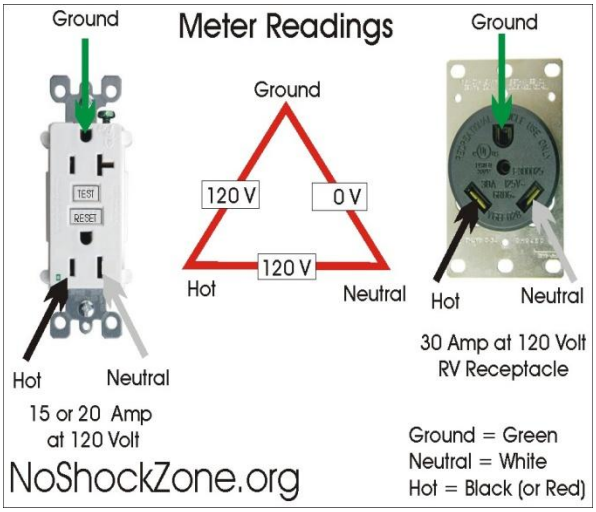
Picture 2: black “hot” wire under screw

Finally, and perhaps most importantly, the green ground wire needs to be properly terminated under the green "ground" screw.



Picture 3: green ground wires and screw

The same color codes and wire orientation apply to 30-amp RV plugs as well, which you can see in the next illustration. Typically, the letter "W" indicates the white neutral connection, and the letter "G" indicates the green safety ground connection, but the same polarity pattern

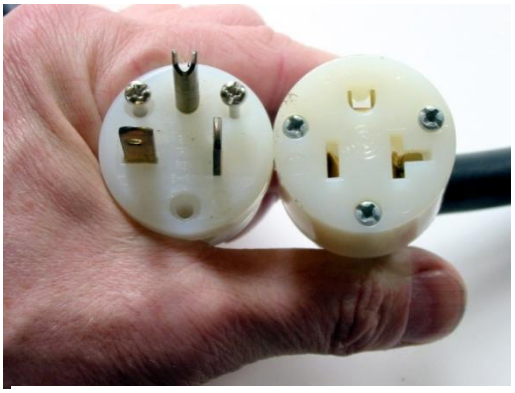


2-amp 3-amp comparison

holds true for both 20-amp and 30-amp RV connectors.

If any of these conditions are not met, DO NOT PLUG THE RV INTO SHORE POWER. An improperly wired shore power plug can cause the entire body of the RV to be energized with 120 volts, even if the RV's internal circuit breakers are in the OFF position. Never plug an RV into shore power with a miswired plug or extension cord.

Also, for quick reference, here's what the ends of a typical 20-amp extension cord look like:



20-amp extension cord ends

Notice there's a male plug on the left side of the picture, and a female plug on the right side. Note the orientation of the plugs. While holding them both facing you, the sideways

"neutral" blades are reversed on the left and right side of the picture. That is, the male plug has its neutral blade on the left, while the female plug has the neutral blade on the right. That's because they're expected to be rotated 90 degrees to mate when making a connection, in which case the neutral, hot, and ground blades will match up. This single idea is what gets lots of RVers in trouble when putting a new plug on an extension cord. That's why I NEVER trust an extension cord without molded factory ends. Once a non-electrician (and yes, sometimes even an electrician) installs a new power plug, all bets are off as to its correct wiring. It's best to check for yourself.

Hot-skin testing

There are two different methodologies to test for an RV hot-skin condition: passive and active. The passive method allows you to confirm the wiring is correct by checking resistance from the ground pin of the plug to various parts of the RV's body. And while passive testing is certainly best for troubleshooting complex electrical problems, the active method is perhaps the quickest and most reliable under real world conditions. We'll cover passive testing in a future article, but here's how to test real-world machinery for dangerous voltages.

Active testing

Active testing implies that after physical verification of the power plug for obvious signs of damage or tampering, you simply plug the RV into a known-good shore power plug and test for the hot skin condition. Always be aware that there's the possibility of the RV body being instantly energized to 120 volts in your repair shop. And there will probably be no obvious signs of this shock hazard. Unlike on television, there will be no blue glow, no sparks, nothing that hints the vehicle is now a shock hazard. This is when I like to do phase one of hot-skin testing with a non-contact AC tester such as the Fluke VoltAlert 1AC-A II. *(See below.)*

These testers are commonly used by electricians to detect energized power plugs and extension cords. And while the standard non-contact testers are rated to detect from 90 to 1,000 volts, many will reliably beep with as little as 40 volts AC on the body of an RV. See below for my RV Hot-Skin model, which can be energized from zero to 120 volts for testing. The Fluke VoltAlert 1AC-A II pictured here will detect hot-skin voltages as low as 40 volts per my own test-bench experiments and observations.

The author's RV Hot-Skin model

As you can see, all that's required to check for a hot-skin condition is that you hold the tester in one hand while you're standing

with your feet on the shop floor. These non-contact testers are listening for the "hum" induced in the tip compared to the ground-plane supplied by your own hand, so they won't trigger an alarm if you're standing inside the energized RV itself. That means you can just walk up to the exterior of the RV and place the plastic tip of the tester anywhere on the metal chassis of the RV, which could be the door frame or trailer hitch. If it doesn't beep, then the RV chassis voltage is below 40 volts AC and most likely safe. If it does beep, then something is terribly wrong and you need to move onto step II before touching the RV in any way with your own body.

Non-contact AC tester limitations
Now, here are a couple of warnings about using non-contact testers to check for hot-skin conditions:

- These testers need to have your hand wrapped around them to sense the earth ground. If you hold them with just the tips of your fingers, it's possible to get a false-safe reading.

- Non-contact testers need your feet to be near the ground to know the actual earth potential, so if you're standing on a fiberglass ladder, they won't read properly. Additionally, since non-contact testers are looking for the voltage difference between your hand and the plastic tip of the probe, if you're standing inside an RV with a hot skin and you test your galley sink, they won't indicate trouble when indeed there is. Therefore, always grip the non-contact tester firmly in your hand while standing on the ground outside your RV. And if your vehicle has as little as 40 volts of hot skin potential, the tester should alert you of the danger even without physically touching your RV. You can just slip the VoltAlert pen into your pocket and use it to quickly test any RV you might be working on. It only takes a few seconds to test for a hot-skin condition this way, and you may save your own life or another technician's.

Active testing, part two
Here's the gold-standard way to test an RV for a hot-skin condition. Set your voltmeter for AC voltage above 250 volts. As you can see from the picture below, I've selected the 750 AC volts range on this manual meter, but auto-ranging types just need you to select AC or DC voltage.

As always, make sure you plug the black probe into the black COM connection on the meter and the red probe into the RED VOLTS connection on the meter.
All electricians are taught to use only one hand at a time on a potentially live circuit to avoid shocks across the chest cavity, so use the alligator clip on the black probe tip,

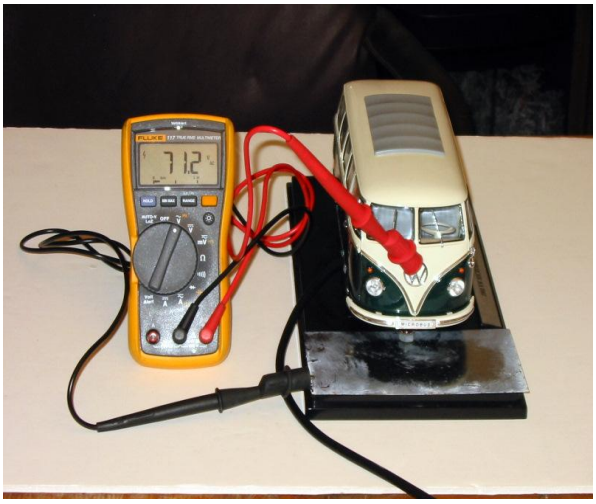
and keep one hand in your back pocket while probing for voltage.

Now, find a known-good earth ground separate from the vehicle such as the pedestal power box or a metal water pipe connected to earth, and clip on the black probe's alligator clip. You'll need to punch through any rust or paint, so an exterior bolt or machine screw is usually a good choice.

Now, without touching the body of your RV with your own hand, poke the body or chassis of your RV with the sharp tip of the red probe. Again, this probe needs to make connection to the metal skin of the RV, so to avoid making little holes in the paint job, pick a spot like the trailer hitch or a chrome door knob.

In my model below, I'm using the VW emblem on the front of the RV to make the proper connection. But be aware that not all metal pieces on an RV are necessarily connected to the vehicle's chassis or frame, and a fiberglass skin may, in fact, insulate a metallic emblem from the RV's own system ground, thereby giving you a false negative hot-skin read. The safest place to test for chassis voltage potential is the RV's frame or hitch. Again, a voltmeter will not indicate the actual voltage if you're touching plastic, paint, or rust with the probe tip, so you must push the sharp tip into fresh metal.

Perhaps the safest method is to use alligator clips on both probe tips to avoid any possibility of getting shocked. Note this is an auto-ranging meter, so no voltage selection is necessary, you just pick AC Volts and it figures out the voltage range on its own.



The probe needs to make connection to the metal skin of the RV.

Next, while both probes are making contact between the RV chassis and your local earth ground, you should read very close to 0 (zero) volts, and certainly less than 3 volts. It's not exactly zero volts because no two grounding points or neutral to ground points are at exactly the same voltage potential. Here's why: The National Electrical Code, in Sec. 210.19(A), FPN No.4, states: *"Conductors for branch circuits as defined in Art. 100, sized to prevent a voltage drop exceeding 3% at the farthest outlet of power, heating, and lighting loads, or combination of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5%, provide reasonable efficiency of operation."*

This calculates to an allowable 6-volt drop in a typical branch-circuit run to your shop (5% of 120 volts equals 6 volts). That makes sense, since you might have 120 volts at the incoming electrical panel, but it could easily be down to 114 volts at the shore power outlet on your repair bench simply due to other current induced voltage drops

along the way. However, it's not the black/hot wire dropping the entire 6 volts. There will be equal but opposite 3-volt losses in the supply (black/hot) and return (white/neutral) conductor which adds up to the total 6-volt drop. And since the ground wire isn't supposed to be bonded to neutral anywhere except at the incoming power panel, it won't carry any neutral/return current, and should thus be unaffected by whatever voltage drops the hot and neutral wires are experiencing. Therefore a Neutral to Ground or Ground to Earth voltage difference of up to 3 volts is a realistic condition in a normal 120/240-volt power distribution system in a home or shop.

If, however, you read 10 volts, 50 volts, or especially 120 volts between the RV chassis ground and earth, that's the time to turn off the circuit breaker feeding the RV, pull the power plug, and start looking for the actual source of the problem. But be careful: An RV with a hot-skin condition has the potential to electrocute and kill anyone who touches it and the ground at the same time. And damp concrete, such as the floor of your shop, is definitely a good enough ground to cause electrocution.

Quick Tips

- **Do a visual inspection of the power plug for any RV prior to plugging it into shore power.**
- **Perform a quick hot-skin test using a non-contact tester after plugging an RV into a power receptacle.**
- **When performing any electrical work on an RV, use a voltmeter to confirm less than 2 volts on the body of the vehicle. If the voltage reads more than 2 volts, do not proceed until you determine the source of the hot-skin condition.**
- **If you feel the slightest tingle or shock from an RV you're working on, avoid all contact, shut off the AC power at the pedestal, and begin passive testing for a grounding problem.**
- **Never leave an RV with a hot-skin condition powered up and unattended, since it can electrocute the next person who touches it.**

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Generating Solutions:
A Troubleshooting Guide to RV Generators

Source: Onan

After the chassis, the generator is the item that RVers submit the most service claims on, say RV technicians. Some RVers don't know how to properly use their generator or are afraid to use it regularly, so "operator error" can be an issue.

The following list of commonly seen problems has been compiled to help techs diagnose and repair generators. Remember: These are just a few of the scenarios a technician may come across and, as always, there are exceptions to every rule.

Generator won't start – Probably the most common issue. There are a number of possible reasons for this problem. If the generator:

- **Cranks but will not start –** Check the battery voltage, air filter, fuel supply, spark plug gaps, valve, and engine timing.

- **Will not crank –** Check the battery voltage, fuses, and all DC connections between the coach and the batteries.

- **Is hard to start –** Check for air in the fuel system, fuel leaks, a clogged fuel system, lack of fuel, or dirty filters.

- **Takes a long time to start –** Try priming the genset by holding the stop button. If and only if it is a diesel set, check the glow plugs, since they control how much preheat is needed before the generator starts.

- **Starts/stops on its own –** First, determine if the genset is connected to an auto gen start (AGS) system. If so, check to see if the AGS is on. This could be the reason the genset is turning on or shutting down unintentionally. For example, if the AGS is on, the genset will shut down when the battery voltage is back up. If this is not the problem, verify that all of the connections are tight and that there is proper contact and continuity. Sometimes a loose or broken wire may cause the failure.

- **Smokes after starting –** This could indicate a number of issues. The two main things to consider are whether the genset is gas or diesel and the color of the smoke coming from the generator. These can help you quickly diagnose the problem or rule out other potential issues.

On a gas set:

- **White smoke** is from unburned fuel vapors. This is caused by low combustion temperature or timing.
- **Black smoke** is from incomplete burnt fuel. Clogged air filters, too much fuel, and high fuel pump pressure might be the problem.

- **Blue smoke** is from excessive oil burning. Check for excess crankcase pressure, bad piston rings, and oil leaks.

On a diesel genset:

- **White smoke** is from partially burned fuel vapors. Check the fuel system or timing for any issues.
- **Black smoke** is from incomplete burnt fuel and can be due to clogged air filter, injection pump failure, incorrect timing, a nozzle with poor spray pattern, or dribbling nozzles.
- **Blue smoke** is from excessive oil burning. Again, check for excess crankcase pressure, bad piston rings, or oil leaks.

A tripping breaker – If the breaker continuously trips or there is a fault indicating an overload, it could be because the battery charge rate is set too high. Check battery charge rates on the inverter or battery charger. Lowering the charge rate may help, but be aware that doing this will make the battery charge time longer. This can be a good thing, however, since low charge rates are easier on batteries when the generator is running for longer periods (i.e. running an air conditioner in hot weather).

No AC output – First check to see if the circuit breakers have tripped, then look at the voltage regulator. Most gensets won't run without AC output, so if the set runs but you're not reading any voltage, check all of the wires and connections.

Some general safety tips – Generators may look small compared to other parts of an RV, but they create a lot of power and can be extremely dangerous when not used or serviced properly. As a general precaution, follow these safety tips when inspecting or servicing an RV:

- **Always unplug the remote harness when working on a genset**. This prevents someone from unknowingly starting the generator when it could endanger the person working on it. (The exception is if you're testing the remote.)

- **Turn off the AGS system.** If the generator is equipped with an AGS system and you're not testing the AGS's functionality, the AGS system should be turned off to prevent the genset from starting up and endangering the person working on it.

These tips should save you time on the next generator repair. Please remember, though, that this is a guide and not the final word on genset problems. If your particular situation doesn't respond to these suggestions, you should contact the RV generator manufacturer.

"Operator error" can be a factor with generator problems.

Honest Upselling

By Tony Yerman

I once knew a technician who repaired a generator, only to have it almost fall out due to rotted frame mounts. I had to ask him, “Are you wearing blinders?” He should have noticed that the generator he had been working on was only hanging on by a thread. Certainly, the owner saw that there was a great deal of deterioration and brought the unit back. We made additional repairs to the frame, and all was forgiven. But that’s not the ideal way to sell service. If I’m missing something so integral to a repair, so close to the piece I’m working on, then there may be other problems that need fixing just a few feet away. Could there have been an unusual noise when the unit was brought into the service bay? Did the tech trip over an inoperative or broken step just to enter the vehicle? Are my techs wearing blinders?

Look beyond the obvious

Customers bring in their vehicles for specific problems, but there may be other issues they don’t know about. It’s part of both the service writer’s and technician’s job to look for and inform owners of other needed repairs. A technician shouldn’t just perform the tasks on the repair order with blinders on. Does he look any further than what’s right in front of him? If not, he should. Selling a customer something he truly needs to prevent further problems or a breakdown while on the road is as legitimate as selling him a new awning or a set of leveling jacks or lawn chairs. These kinds of services need to be brought to the owner’s attention by attentive service writers and techs.

Prioritize for customers

People tend to buy what they want, not necessarily what they need. Why not sell them both? If a tech finds something else that’s broken, inoperable, or just worn out, he should make note on the RO and communicate with the service writer. The service writer should create an estimate list of all the items in order of priority, with safety issues on top. This helps customers decide which items need immediate attention and which can be postponed if necessary.

By prioritizing, you have created an up-sell list that shows what they must attend to versus what they’d like to buy. Now they must fight the tug-of-war of economics and whether they will take on the cost of everything.

Needs versus wants

Parts and accessories people might disagree with me, but I believe the customer must first be sold what he needs and then what he wants. I don’t want a customer to stop in with his lawyer telling me that the brand-new set of automatic remote-control hydraulic levelers I sold him worked great just before the accident he had because we failed to sell him needed tires and brakes. Customers aren’t necessarily experts on how their vehicles work. I believe they appreciate being told about needed additional repairs and having them prioritized. I always gave my customers choices, and they trusted me and usually found the money to do the extras. If they had to postpone repairs, they came back to

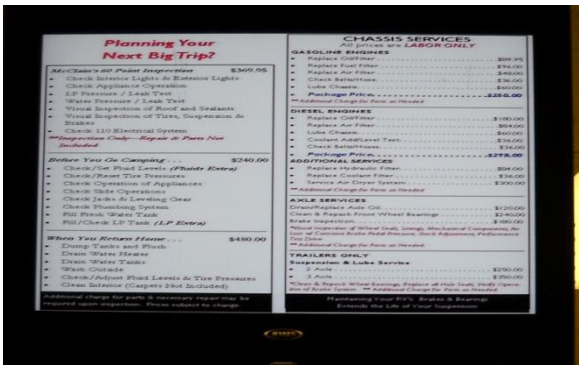
me when they were ready. Sometimes you just need to explain to them the importance of a certain item or job.

Create a service menu and add displays
To sell more at your dealership, think about what tire stores do – most offer other repairs and services. They display shock absorbers and new batteries that customers can look at while they're waiting. There's usually a menu with prices for all sorts of maintenance and repair items.

An RV service department can also create a manual for service writers and menus that can be displayed for the customer. Certain accessory items can be displayed in the service department, such as sway control or steering stabilizers, both of which can be marketed in terms of safety, comfort, or a means to correct a repair issue.
Your service department can use a publication like the RV Learning Center Service Management Guide to help create specials and pricing based on the flat-rate labor times found there.
With a little imagination, you can take off the blinders and sell more needed service – and your customers will actually appreciate it.

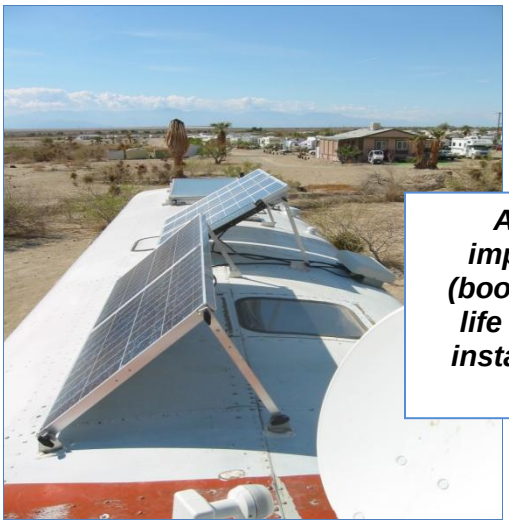
RVDA Service Consultant Tony Yerman is a Master Certified RV Technician and the author of the RV Damage Repair Estimator. You can contact him at tyerman@rvda.org.

Examples of service department menus and displays that help sell more service and products.



What's New Under The Sun

By Dick Kent



An RV solar system gives customers two important benefits: The freedom to dry camp (boondock) without low batteries, and extended life for their batteries. This article explains the installation, operation, and start-up process for solar systems.

Current estimates are that 5,000 solar systems are installed in RVs each year. Many of us in the solar industry encourage manufacturers to install solar as standard equipment or at least pre-wire to help ease the aftermarket installation of this desirable system.

Components of a solar system:
Solar modules - aka, solar panels or PV panels - produce DC volts when in sunlight, and are used to charge batteries.

Charge controllers have evolved from the simple on/off relay type (with or without a meter) to a PWM (pulse width modulated) design and to the latest addition to charging strategy called MPPT (maximum power point tracking). These deliver maximum energy from the solar modules to the batteries by "boosting" the full voltage of the module until the batteries near full charge. Then they drop into a float stage to maintain the batteries at a full state of charge at the end of the cycle.

The selection of the charge controller is important to draw the maximum energy from the solar module, control the charge, and prevent overcharging.

Batteries are the heart of the system, and most experienced RV folks know that true deep-cycle batteries are the 6-volt golf cart size, with 2 to 3 times the usable capacity of comparable 12 volt RV/marine types. The AGM (adsorbed glass matt) type eliminates the need to add distilled water, ever.

Wiring is all important in the proper installation, especially with the newer high performance modules (44-cell high voltage) or multiple modules. Ensure that the ampacity rating is correct for the wire to

deliver the maximum energy to the batteries with no more than a 3 percent voltage drop.

Safety Information

The solar electric module (panel) generates electricity when exposed to sunlight. Protect yourself and your equipment from electrical hazards by taping a cardboard cover (such as the box lid of the solar kit) over the glass face of the module when wiring to temporarily disable the module.

Observe proper polarity. Improperly wired electrical devices can cause severe and immediate hazards. Always check, then double check your wiring connections to be certain they are done correctly. Marking wires in a permanent fashion will help you and future techs working on the system.

Batteries release hydrogen gas. Extreme care should be taken to prevent sparks when working around them. Also, use protective eye wear and wash thoroughly with water if skin or clothing comes into contact with battery acid or the corrosive material which may have accumulated on the outside of the battery.

Mounting the modules

Placing the modules on the RV's roof requires some planning to ensure they won't be shaded by other items, such as ACs, antennas, storage pods, or railings.

Ensure the panel isn't blocked by other rooftop components.

A rule of thumb is to maintain a distance from these items equal to the height of the obstruction. The set-backs from the edges of the roof should be a minimum of 3 to 5 inches on the sides and at least 12 inches from the front. I recommend placing the modules in a way that allows future additional modules to be mounted.

Mounting the modules demands the cleaning of the attachment points to attain good adhesion and avoid possible water leaks. I use DICOR under the mounting feet and over the screw heads. This product was developed for rubber roofs, but it has great sealing and adhesive properties for all surfaces.

The attachment points need sealing with a good adhesive.

Use either a self-drilling sheet metal screw or, with pilot holes, a plain sheet metal screw to attach the mount feet. I use all stainless steel hardware and mounts to avoid rust and to raise the module 1 to 3 inches off the roof to allow air circulation. The modules lose efficiency (voltage) as they heat on the roof of an RV under direct sun. Some low voltage (15- to 15.5-volt) modules don't achieve a high enough voltage to ever fully charge the batteries when attached tightly onto the roof and are nearly impossible to raise for

troubleshooting. Personally, I like to use an ultra-high bond 3M industrial double-back tape on smooth fiberglass roofs for neatness and for not penetrating the roof.

Wiring

Wire routing in the aftermarket setting is a challenge but needs to be done correctly for the system to work properly. Plan the most direct wire run to the charge controller and batteries, thereby reducing voltage drop in the circuit. A route down the refer vent stack is the most convenient to allow placement of the controller and get below the RV floor. Do not take the shortcut of attaching the solar system to the terminals on the refrigerator - high voltage spikes can seriously damage the control board. We are charging the batteries, not heating other circuits in the RV.

A good alternate route is to follow a plumbing vent pipe from the roof through a closet and on through the floor to the batteries. The recommended wire routing is to use a junction block on the roof to connect multiple modules in parallel, and then, with heavy-enough gauge wire, to the charge controller and directly to the batteries, not tying into any other circuit. Proper installation uses a fuse within 18 inches of the battery, in the positive leg of the circuit matching the ampacity of the wire. (Example: 30 amp ATC fuse for 10 AWG wire)

Charge controllers

Charge controllers are polarity-sensitive, so it's very important to use two conductors of different colors, or mark the conductors clearly and permanently at all connection points. Always use stranded copper wire in these circuits. Whenever possible, use charge controllers with a remote temperature sensor and a temperature compensation feature. A pair of small wires, typically 18-22 awg shielded cable, should be run with the conductors routed from the controller to the batteries where the sensor is mounted. RV batteries experience a wide range of temperatures during their normal use, and all charging sources that **fully charge** batteries (that is, achieve a voltage at the gassing point of 14.2) should be temperature-compensated to give a full charge in cold weather without overcharging in hot weather.

Battery connections should be made with heat-shrinkable crimp ring terminals on both the positive and negative battery terminals to prevent corrosion. The preferred connection to batteries is one that uses the opposite corners of the battery bank for all charging and usage to make the batteries act as one battery, for a more even charge and discharge, hence longer life.

Testing and familiarization

Prior to making the attachments to the charge controller, a simple voltmeter test will verify the wire runs are identified and polarity is correct. The wire pair from the batteries should read the same voltage as measured at the batteries, and the pair from the solar modules (PV) should indicate an open circuit voltage (in daylight) of 18 to 22 volts, also with proper polarity.

Solar systems make RVers more aware of the need to keep batteries properly charged and of monitoring energy consumption. A properly installed solar charging system enables RVers to stay in their favorite camp spots and provides clean, quiet power from fully charged batteries.

Dick Kent is an expert on solar systems who travels the country in his solar-powered Winnebago.

TOP THIS!

Wish I'd Listened To My Mother

By Steve Savage

Three other techs had already been stumped by a coach's intermittently tripping circuit breakers. The author came up with an ingenious new theory involving the coach's transfer switch and AC compressor.
But was the problem even electrical?

It's funny how this job goes. Some days I can do no wrong and am convinced I am the God of RV Repair. Then comes the call that jolts me back to reality. Reality in a recent case was a large diesel pusher which had already defeated three technicians and added them to the notches on its belt.

This coach had an intermittent power problem. When on the road, with the generator serving up the power, the 50-amp main circuit breakers in the coach would unpredictably trip. Naturally, that killed the AC and whatever else was operating at the time. To correct the problem, the owner would pull over, reset the breakers, and be on his way. Sometimes the breakers didn't trip again for months; sometimes they tripped in a matter of days or hours. They never tripped unless the coach was in motion.

The obvious solution?

The logical diagnosis would seem to be weak breakers. And changing out the main breakers was exactly what the first three service centers did when the coach darkened their doors. It was possible that a short existed somewhere in the wiring, but ohming the mains to ground and neutral showed nothing but "OL" on my meter. Given that the obvious had already been done, I decided to go with a more exotic theory. I imagined the transfer switch points bouncing rapidly enough to short-cycle the AC compressor jumping amperage to lock-up level. Understandably, I would have expected the AC breaker would throw ahead of the main circuit breaker, but calls to product vendors suggested such a scenario could not automatically be ruled out.

Round two

I dutifully checked amp draws at the main, powering up everything in the coach, even going so far as to run both ACs on their heat pump settings, but readings fell far short of those necessary to trip the breakers. I went through the transfer switch, again finding nothing amiss. The transfer switch vendor offered a free, just-in-case replacement but I deferred, having no desire to wrestle 6-gage wires onto a new switch in the absence of concrete findings.

After several hours, I surrendered and credited the time spent to my education,

rather than the owner's checkbook. I completed a few minor repairs and turned the coach over to its owner. For awhile, it seemed like maybe I had vanquished the gremlins.

They're b-a-a-a-c-k!

For several months after my last visit to the coach, things were peachy - no tripped breakers. Then, early this fall, while I was making some minor repairs on this same coach, the owner asked if I wanted to know what had been tripping the main breakers. It seems that, like the undead, the gremlins had reappeared.

And the owner had accidently discovered the real problem.

As it turned out, while he was resetting the breakers for the umpteenth time, he happened to notice that the closet doors hadn't been latched. Like so many pushers, mirrored closet doors cohabitated on a dual track across the back wall of the coach. The door that normally slid over the breaker box was mounted in the outer track. The door gliding on the inner track was on the side opposite the breaker box and normally would never be slid all the way over the box. If, however, the doors weren't latched and the coach swayed, the door on the inner track slid over the breaker box and the door flange caught the levers on the main breakers. Then, when the door slid the other way, it tripped the breakers.

Latching the doors prior to hitting the road and the problem was solved.

So I learned two things: Sometimes an electrical problem has nothing to do with electricity. And if I had listened to my mother and learned to close doors when leaving, my record as the God of RV Repair would still be intact! Sometimes it's the simplest darn things that bite you in the butt.

Steve Savage is a Master Certified RV technician, the owner/operator of Mobility RV Service in Bristol, TN, and a member of the RV Technician Advisory Group. His articles appear frequently in consumer and industry magazine.

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New Norcold Refrigerator/Freezers

Three new Norcold portable compressor refrigerator/freezers keep food and drinks cold even on hot summer days. The NRF-30 has a capacity of 1.06 cu. ft., or the equivalent of 42 12-oz. cans, while the NRF-45 is sized at 1.59 cu. ft. and can accommodate 64 cans. The largest model – the NRF-60 – has 2.12 cu. ft. and holds 86 cans. The models use CFC-free foam insulation and refrigerant to work better than traditional coolers, which require ice. They feature separate freezer-only sections, easy-to-clean removable wire baskets for convenience and organization, and stainless steel interiors to prevent staining and improve cooling. The hermetically-sealed compressor has built-in low-voltage protection. An electronic control panel displays the internal temperature and allows the user to set the desired temp. An indicator light alerts owners to installation issues such as improper ventilation or high ambient temperature. The models offer three settable levels of protection to prevent battery drain. An easily reversible and removable hinge lid is included.

RV Manufacturers Recall Models With Defective Wheels

Three RV and travel trailer manufacturers are recalling some of their 2011 models to replace wheels that may be defective. Because of improper assembly, the wheels could break and increase the chance of a crash, according to the National Highway Traffic Safety Administration (NHTSA).

The wheels are described as 15" x 6" white spoke or modular design steel wheels with a 6-hole bolt pattern. The NHTSA report states that the wheels may have "inadequate weld penetration between the outer ring and the center plate." Problems with the quality of welds holding the wheels together could cause wheel failure.

Heartland Recreational Vehicles LLC is recalling some 82 Caliber, Elk Ridge, Focus, MPG, North Country, North Trail, Sundance, and Trail Runner travel trailers that are equipped with the defective wheels.

Coachmen RV Co. is recalling about 215 Catalina and Freedom Express vehicles for similar wheel-weld problems.

Keystone RV Co. is recalling 2,338 of its 2011 Cougar, Energy, Hornet, Laredo, Outback, Springdale, and Sprinter travel trailers equipped with the same wheels.

Skyline Corp. is recalling 57 of its Aljo, Layton, Mountain View, Nomad, and Weekender recreational vehicles and fifth-wheel trailers.

The recalls began in late December and continue this month. Manufacturers are replacing the wheels free of charge. Consumers with questions may be referred either to NHTSA's vehicle safety hotline (1.888.327.4236) or to their manufacturers' customer service offices. (Keystone: 1.866.425.4369; Skyline: 1.800.733.4250; Heartland: 877.262.8032).

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