RV – Generator Grounding

May 7, 2016 - by Jim Aspinwall, NO1PC, WBCCI 5510

Introduction

Electrical 'things' are confusing enough. Batteries, plugs, wires, 'devices', USB, 12 V, 120 V, 30-amp, 50-amp - and then we should probably be concerned about what connects to where, what's 'hot', what's 'ground.'

Is 'ground' any metal thing that's not a wire, or it is really GROUND as-in EARTH? Is there a difference and why should we care?

There are at least two VERY good reasons to implement proper (National Electrical Code and local code required) grounding of your RV, by the site-provided power pedestal or when using a portable generator:

- SAFETY - of people and pets,

  and

- SAFETY - of equipment and property.

Basic Points To Know and Consider

I will start the discussion with a list of the basic concerns and related 'pieces' of this topic. Any one or all of these could summarize part of the situation and provide answers to one or more lingering questions, or questions you don't yet have:

- Earth/ground is considered THE basis or reference point of zero-electrical potential.
- Earth-ground literally means the earth, dirt, soil. The very foundation we sit upon.
- Safety concerns begin when any object is electrically "above earth-ground potential". This means you could measure voltage between earth-ground and some object.
- Safety concerns also come up if you are or can be exposed to an electrical charge/potential between any two things.
- Humans (and our pets) are typically in contact with "the ground" and then make contact with other objects that may or may not be at the same or higher electrical potential.
- Humans and some animals are variously sensitive to low-level shock at or above 4 milliamperes of current flow (technical term but relates to voltage levels and GFCI (ground fault) protection.

- A low-voltage system is anything with an AC or DC potential of 49v or less - our 12 V DC battery systems are low-voltage.
- A high-voltage system is anything with an AC or DC potential of greater than 49v - house, pedestal and generators are high-voltage.
- It is fairly difficult to get a shock sensation or injury in a low-voltage system (12 V DC vehicle, RV.)
- It is fairly *easy* to get a shock and sustain injury in a high-voltage system (120 V AC house, generator.)

- The 'ground' wire, pin, socket, connection at outlets and in power cords and RV breaker boxes is a safety 'ground', not specifically a direct Earth-ground.
- The purpose of the safety ground is a part of a safety/electrical fault detection method - the ground-fault outlet/breaker.
- There IS a significant difference between what many think of as 'ground' but is really just a frame, chassis, panel, container, and true Earth-based GROUND.
- Your RV frame/chassis is NOT 'grounded' by virtue of a metal jack- or stablizer-plate coming in contact with grass, dirt, gravel, a puddle, pavement, etc.
- Your generator frame/chassis is NOT 'grounded' by virtue of placement on or contact with grass, dirt, gravel, a puddle, pavement, etc.

- Neither the green/'ground' wire in your electrical cord from RV to generator, nor a separate additional wire connecting RV chassis to generator frame/chassis is actually 'grounding' either one. These connections only help ensure that both items are at the same electrical potential, which may be above true Earth-ground potential. They DO NOT 'GROUND' either or both items.
- ONLY a solid known conductor IN the Earth is an EARTH-GROUND point - not the surface, dirt, puddle.
- ONLY connecting BOTH the generator AND the RV to THE EARTH-GROUND can ensure that they do not attain and electrical potential above that of ground.
- Personal safety/avoiding electrical shock is one part of the safety concern. Preventing electrical malfunctions, damage to RV appliances and electronics, and preventing fire are the other aspects of concern.

- Just because you've been lucky before does not mean you will always be lucky, or safe.

Discussion

Admittedly electrical systems, wires, generators, connections can be very tricky, confusing and almost contradictory at times.

Professionals and technical 'enthusiasts' alike can relate to experiencing and being challenged by some of the most obscure and bizarre aspects of electricity.

While in many ways "all electricity is the same", in just as many ways it is not. Our vehicle and RV 12 volt battery and solar systems and devices behave much differently than our home and RV 120 volt AC systems. Obviously one is lower voltage and the other is dangerously higher, but AC provides some interesting characteristics that make it less obvious as a safety concern.

AC and DC power may be used for same or similar purposes - to light or do work - depending on how the device is designed. However, one type of power may be better-suited to some devices and types of work than the other.

D.C., Direct Current, circuits require and operate with *direct* physical connections only. A.C., Alternating Current, circuits can work with both direct connections (wires, connectors, switches, bulbs...) as well as indirectly coupled connections (typically transformers, or inductive/'radiated' coupling, much like how radio waves travel through the atmosphere.

Because AC-power is implemented and functions much differently, typically at much higher energy levels than DC-power, at least that it can traverse or be imposed on other objects even without direct contact, it is a more significant safety concern.

While there are many general rules and practices for handling DC-power, there are many more specific rules, practices and even laws concerning AC-power.

We can list, and there are many, covering the laws, the rules, the methods, but the how and why electrical safety is a concern, how to properly implement it to protect against known and possible risks is less obvious.

There are a few ways to represent how insidious, tricky, and unpredictable AC-power risks come about without going in-depth with electrical theory, absolute measurements and complex circuits. I don't want to leave the impression that AC-power is magical, mystical - that its behavior and control of it is only for the elite or special 'wizards' - but sometimes analogies and visualization can make it more relevant to a general audience that simply wants to enjoy safe RV-ing.

What is AC Power?

AC, or A.C., is an acronym for alternating current. AC-power may be viewed similar to a musical note or sound - it is electrical energy that shifts in a wave (in U.S. power systems) 60 times per second. If you could hear it it would be audible as it is within human hearing range.

As a wave it is more commonly associated with, taken advantage of through its property of being electro-magnetic waves. It can 'travel', move, be directed and transported through a variety of electrical components and transfer systems, and can be used very efficiently to make other things move - like fans and pumps.

AC-power is most often created by a rotating source - a generator - driven by water, steam or fuel-driven engine. This is a very efficient way of generating the 'wave'. Being an electro-magnetic wave the power can be efficiently transported over pairs of wires, through transformers that can increase or decrease the potential energy to levels usable by many items.

Commercially, on the domestic power grid - AC-power starts out and is transported at very high potential - 100,000 volts. When the power is transported to points of consumption, it is reduced in potential to make it safer and more manageable for connection to businesses, homes and our devices.

At our homes power arrives at 220-240 volts through two opposite circuits of 110-120 volts. The 220-240 volt connection is more efficient for large appliances - ovens, electric dryers and air conditioners. The 110-120 volt connections are more appropriate for lighting and small appliances and electronics.

Internal to most electronic devices the 110-120 volts is further reduced, regulated and even converted to DC power necessary for electronic circuits (computer chips and amplifiers) to function.

The fact that AC-power is an electro-magnetic wave that can surround, emit (radiate) from and be coupled or transferred to and through metal/conductive objects is the very reason it is also a potential safety hazard if and when coupled to devices we do not want to be so energized - other wires, generator frames, the chassis of our RVs. This is specifically where the grounding concern comes into play.

Grounding To Prevent Objects from Being Electrically 'Charged'

At generating stations the enclosures, piping for the wires, and connection boxes all provide not only a mechanical shield to physically protect the circuits - from damage and our exposure to them - the metal enclosures are also grounded to Earth-potential so that if a wire or connection shorts out the metal surrounding do not become electrically charged.

Earth-grounding the enclosures can also keep the electro-magnetic wave from transferring energy to other objects. Without this containment and virtual shorting out or blocking of the wave to Earth-ground, the electrical pipes (conduit) and connection boxes could become 'hot' circuits causing injury, death or possibly fire.

Again - it is this electro-magnetic property of AC power that makes it efficient to generate, transport and use, but also challenging to provide reliable safety measures for. The higher voltage is also a significant concern. It is much easier to encounter a shock or injury hazard from this higher 120 or 240 volts than from a lower 12 volt circuit.

Grounding In An Off-Grid/Field Environment

When you deploy your generator in the field, off-grid, boon-docking, there is no previously and deliberately engineered "electrical grid" and infrastructure providing for mechanical or electrical shielding or Earth-ground and safety.

Because of soil resistance and relatively poor/non-intimate contact with only the surface, as well as debris (foliage, twigs, rocks) simply setting a generator and lowering your jack stand and stabilizers onto the ground does not 'ground' it. The generator frame is likely painted, has 'feet' or pads, and the loose mechanical connections of jack and stabilizer parts make VERY poor if any electrical connection.

The result is that your 120 or 120/240 volt generating system and your RV are floating above (Earth) ground potential. Some of the wave energy from the generator itself could be imposed onto the frame, as as an electro-magnetic wave could interact with and create a potential difference between the Earth and the frame - and this is that safety hazard - your portable electrical system is now "an electrified fence" from the perspective of your feet on the Earth along your body to wherever you touch the generator or RV. The amount of potential difference, the voltage between Earth and the frame/chassis can also vary by how much electrical load is in use.

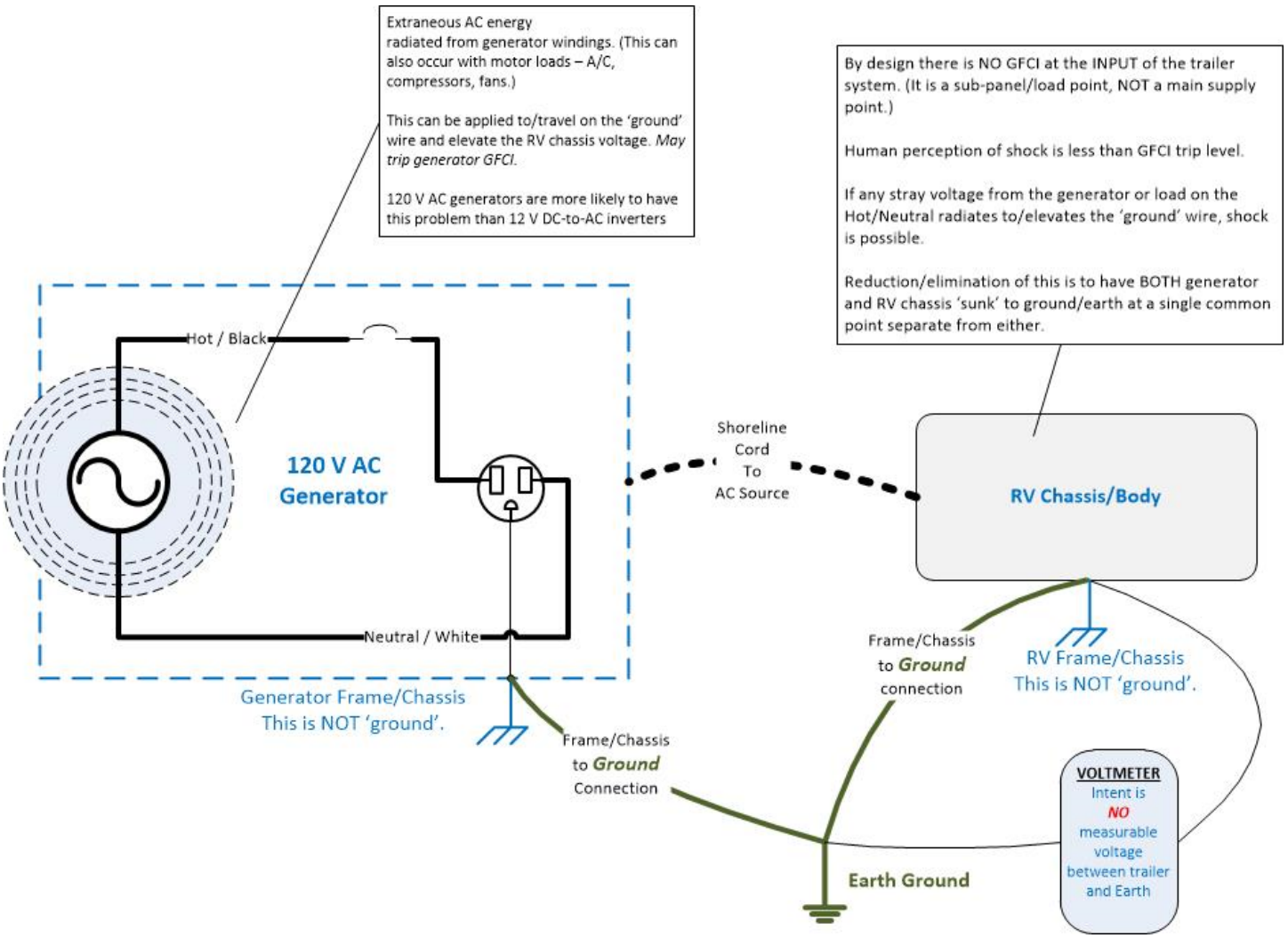
Still another simpler risk in general would be that of a short (partial or total) in the generator electrical system that could place hot 120 V directly to the frame. Power-wise you might not ever know this happened - A/C and microwave still work, battery charges - but your entire RV could be sitting at 120 V. Step out onto your grassy wilderness patio while in contact with the door or hand-rail and experience a very nasty surprise.

Without establishing a very deliberate, direct, physical connection and ultimately protection circuit between the generator frame and your RV chassis to the Earth, you risk at least a mild tingle if not up to a lethal shock.

The relative inconvenience of setting out a few feet of wire and a "tent stake" can be invaluable protection. You, your family, your pets, and your RV systems deserve as close to utility-grade safety as possible.

Aside from injury or equipment damage there are not so subtle consequences should you have to file an insurance claim for medical expenses, property losses or other liabilities that could be denied for not complying with any applicable local standards or insurance requirements.

Proper safety practices are not just a suggestion, a little known requirement, they can be essential!



Implementation

If you can drive a modest "tent stake" and connect a couple of wires you can easily provide this simple safety feature. (Illustration follows.)

Simple Parts List

A short visit to almost any hardware store should be able to provide for the bare necessities:

- Hardware: 2 (1/4") bolts, washers, and extra nuts to attach to your generator frame and RV chassis
- 20-30 feet of #8 stranded wire - does not have to be green, maybe yellow to be more visible?
- Optionally, get at least appropriate size 4 wire lugs to attach to end of wires to attach then to the bolts
- 1/2" copper-clad ground rod. You only need 3 feet (2 into the ground) but may only be able to get an 8 foot rod (to cut-off)
- Ground clamp for rod (get two!)

Add a 1/4" threaded bolt at a convenient location on both your generator and RV frame, leaving enough bare thread exposed to attach the wire lug. Many RVs have an obvious frame 'ground' wire running front to back to handle 12 V DC and general 'ground' currents that are not reliably handled by the steel frame and chassis metals - this is a good point to wire your new ground bolt located near that point.

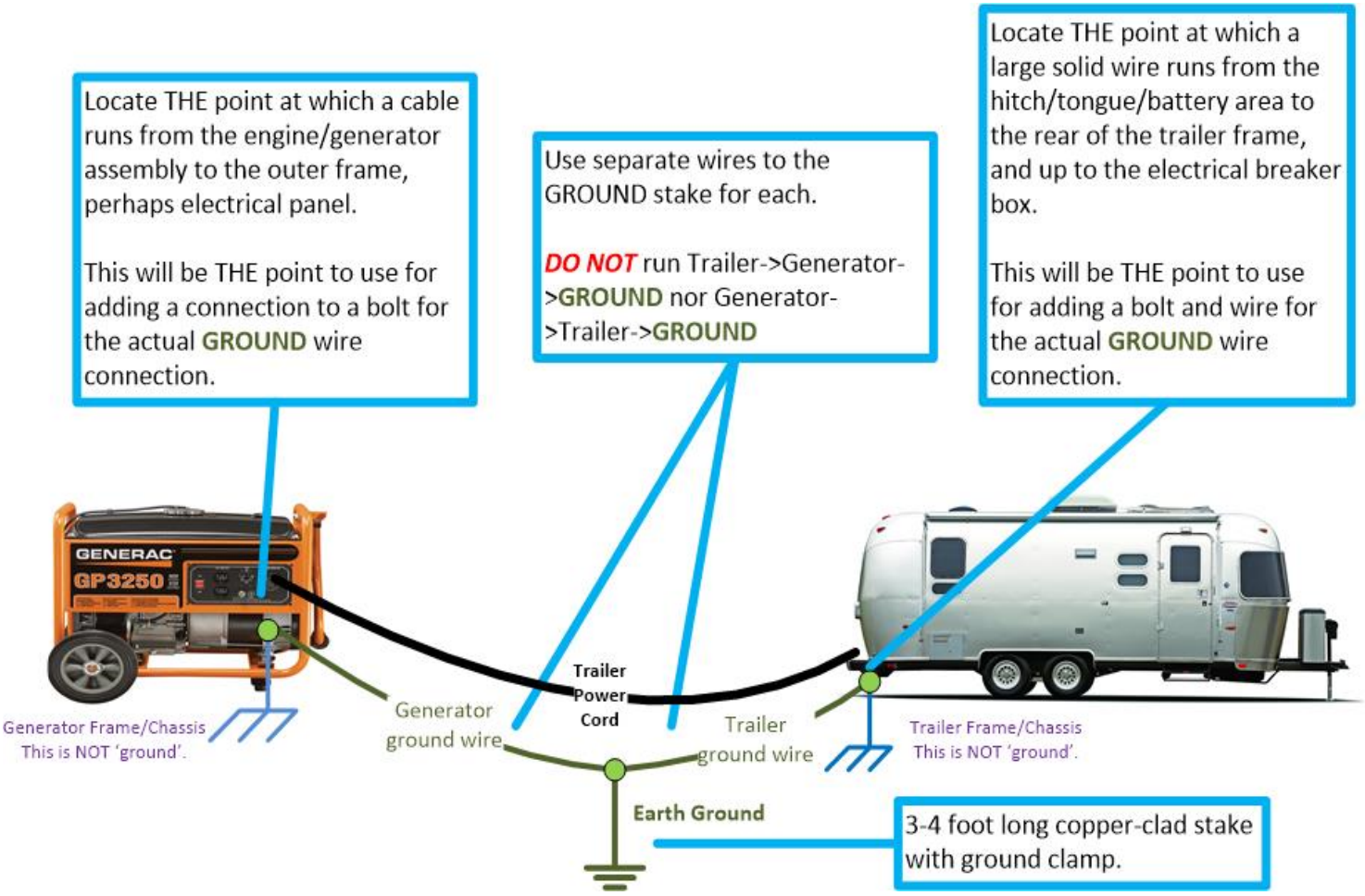
Cut the wire into two pieces - one long enough to parallel the length of your power cord, to go from the generator to the ground stake, the other long enough to go from the trailer 'stud' to the stake. Attach the wire lugs at each end.

Set the ground stake near the trailer to avoid being a surprise trip/ankle hazard. Run out your power cord and generator ground wire. Secure the ground wires first, then connect the power cord. DONE.

Please do NOT scrimp and think to only ground the generator or only ground the RV chassis. If you think to rely on the power cord's 'ground' wire and only ground the generator you have a potential point of failure and the trailer could not be grounded. If you think to rely on the power cord's ground wire and only ground the trailer the generator could be left unprotected. GROUND BOTH!

Keep this grounding wire kit with your electrical cord or generator stash and you're good, and safe, to go!

Illustration below:


Locate THE point at which a cable runs from the engine/generator assembly to the outer frame, perhaps electrical panel.
This will be THE point to use for adding a connection to a bolt for the actual GROUND wire connection.
Use separate wires to the GROUND stake for each.
DO NOT run Trailer->Generator->GROUND nor Generator->Trailer->GROUND
Locate THE point at which a large solid wire runs from the hitch/tongue/battery area to the rear of the trailer frame, and up to the electrical breaker box.
This will be THE point to use for adding a bolt and wire for the actual GROUND wire connection.
GENERAC
GP3250
Generator Frame/Chassis
This is NOT 'ground'.
Generator ground wire
Trailer Power Cord
Trailer ground wire
Trailer Frame/Chassis
This is NOT 'ground'.
Earth Ground
3-4 foot long copper-clad stake with ground clamp.

Reference Information

Brief NEC References to RV Power:
http://www.codebookcity.com/codearticles/nec/necarticle551-1.htm

OSHA Reference to Generators:
https://www.osha.gov/OshDoc/data_Hurricane_Facts/grounding_port_generator.pdf

Good Sam Reference to Generator Grounding:
http://blog.goodsam.com/bonding-and-grounding-portable-generators