A Suggested Generator Startup Procedure Employing a Manual Transfer Switch

1. Start generator
2. Allow 4-5 minutes of warm-up time to stabilizes the output
3. For Safety Switches and Interconnect Kits: During warm-up, at the loadcenter, shut off all circuits (Suggestion: Pre-label those breakers you plan to keep energized.)
4. Turn on or plug in your "power restore alert device." (Alarm bell circuit or a non-switched receptacle for a radio, etc.)
5. After warm-up, transfer loadcenter power from PG&E's service to the generator via the transfer switch. Then energize the desired emergency circuits one at a time to give generator time to adjust to the load.

70

Please note that this is just a *suggested start-up* procedure.

With respect to the steps shown:

Step 3: Small, self-adhesive, colored dots work well

Step 4: You'll see what this means in the next slide.

Step 5: This is the power management step. I'd suggest giving a 3-5 second pause between energizing each breaker.

Example of a Restored Power Alert Device

71

Here is my solution for knowing when utility power is restored: a fire alarm bell.

This is the same type of fire alarm bell you heard going off when you had fire drills in grammar school—and I can hear it from *anywhere* in my home.

I wired this into the PG&E side of my safety switch. When power is lost, I flip the alarm switch, which is directly below the bell, on. When power is restored, the alarm instantly notifies us.

A cheap alternative: Dedicate a spare plug-in radio. Have it turned-on and pre-tuned to a strong radio signal, and crank up the volume knob. Then, when an outage occurs, just plug it into an outlet that will *not* be powered by the generator. When the power is restored, bam! On comes some really loud disco music—or whatever.

A Suggested Generator Shutdown Procedure

1. Shut off “power restore alert device”
2. Transfer power back to PG&E service
3. Switch on any circuit breakers that were shut off in Step 2 of startup procedure
4. Shut off generator
5. Shut off fuel supply
6. When cool, decide on whether to drain generator fuel
7. Store generator when cool

72

With respect to the steps shown:

Step3: No need to pause between energizing breakers here. You’ve got 48,000W of power available.

Step 4: Some manufacturers may suggest waiting about 2-4 minutes before shutting off the generator. Check your manual.

Step 7: Those mufflers stay hot for a long time.

Safety Considerations

- Most generator-related deaths are due to carbon monoxide poisoning
  - When in use, keep the generator outside and at least 10-feet from doors or window openings
  - Don't use a generator in an attached garage. Wind gusts can trap high levels of CO inside the garage, and it may seep into the home.
- Install a CO alarm in the area closest to the living space where the generator will be running
- Shut the generator off and let it cool before refueling
- Keep extra fuel at least 10-ft. away from the generator
- Assure that <u>all</u> equipment is properly grounded

73

Concerning carbon monoxide: It is a colorless, odorless, tasteless gas. If you start to feel sick, dizzy, or weak while using a generator, get fresh air <u>immediately</u>.

The good news is that some manufacturers are starting to install CO detectors. Generac is now installing them on all their generators. If carbon monoxide is sensed above a certain threshold, the generator automatically shuts off.

Concerning the last bullet: Go to the next slide.

I'm showing this monster "portable" generator to call attention to the green wire and brass fastener in the blow-up photo at the right. This *appears* to be a proper ground between the engine and the generator cage. The question is….. whether or not the steel below that flat washer, lock washer, and wing nut is bare metal.

Most generator chassis are now powder-coated. Powder-coating provides for a thorough, long-lasting finish because it's done by electrostatic attraction and nothing is left uncoated. But this poses a potential grounding problem. The area of the steel chassis that the grounding bolt attaches to is also coated. Any powder finish, or paint, where the ground connection contacts the chassis must be scraped bare. I was knocked unconscious by such an error.

Further, what you see here does **not** complete the grounding job. The generator must **either** have it's output ground wire, via the generator cord, properly grounded into your home's electrical system **or**, if using the generator at an unpowered job site, that brass bolt needs *at least* a 12g copper wire connected between it and an 8-ft. long grounding rod driven all the way into the earth.

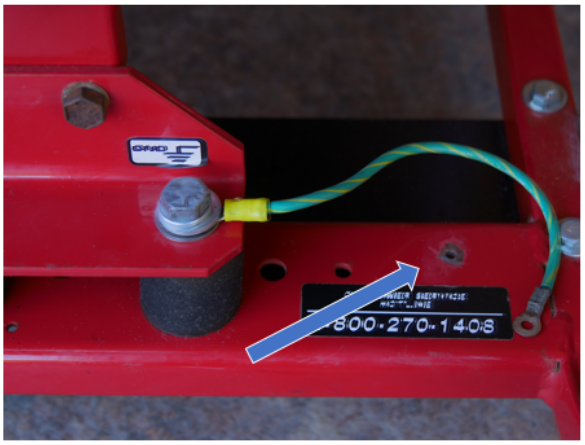
For a ground connection, rather than wrapping a wire around a screw, a simple lug nut like this makes for a superior connection. Strip the ground wire's insulation about 3/8 of an inch. Then use a crimping tool or a pair of pliers to compress the lug's soft copper sleeve onto the wire, and you're set.

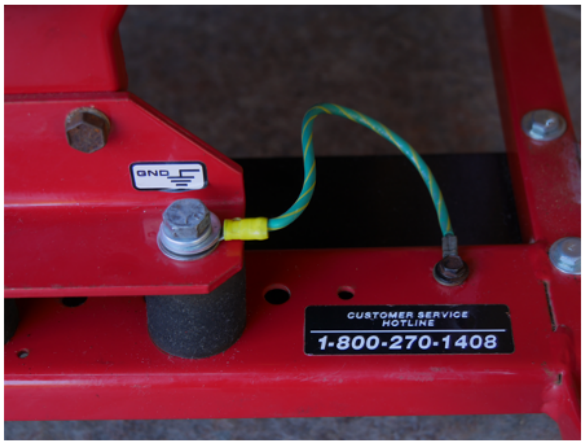
Proper Chassis Generator Grounding

76

This shows what I did to my generator to assure a properly grounded connection. I had to file and sand away the red finish to expose bare metal.

Proper Chassis Generator Grounding cont.





77

I had to do the same finish removal at the other end of the ground wire. In this case, the generator stator was properly bolted and grounded to its support bracket, but those large rubber vibration isolators insulated the support bracket from the rest of the cage. The green wire provides needed ground connection to the cage. The larger bolt on the left is used to connect to and ground the gen-set to an 8-ft. grounding rod, if needed.

[Electricity, like water, always takes the path of least resistance. You want that path to be via a robust, zero resistance, electrical circuit to earth/ground, not through your body.]

Earth Ground Rod

78

This shows the end of the 8-ft. ground rod in our home's electrical and communications center. Here the transfer switch and main loadcenter ground wires are shown securely clamped to the rod. This completes the path to ground.

Safety Considerations (continued)

- Backfeed: A power transfer switch is mandatory (if one is not *exclusively* using the generator's receptacles)
- If using extension cords, use only outdoor-rated cords, and make sure they are of adequate gauge for the lengths and likely loads
- Never attach or detach a generator cable while the generator is running
- If you install a manual safety transfer switch, its best to buy one that has the ability to lock the cabinet (or that can be retrofitted to lock)
- **Have a qualified electrician familiar with generator installations install the system**

79

With respect to the bullets shown:

Backfeed: Unless you're exclusively using extension cords plugged directly into the generator's receptacles, a transfer switch is mandatory.

Electrician: If you are the *least* bit unsure about how to do a generator installation, hire a knowledgeable electrician *familiar with generator installations* to do the work.

Ways to Minimize Problems and Improve System Reliability

- Issues with using motorcycle and garden batteries
- Car battery advantages:
  - Higher CCAs—easier to start
  - More robust battery
  - Warranty (typically 24-36 months vs. 90 days)
- Use a float charger

  (It's also a good idea to have a battery charger, and one that has at least a 10A charge setting)
- Check the battery cell electrolyte levels
  - Use distilled water to top off

80

First: I suggest not making any physical changes to a gen-set during the warranty period. That said, with respect to the slide bullet points:

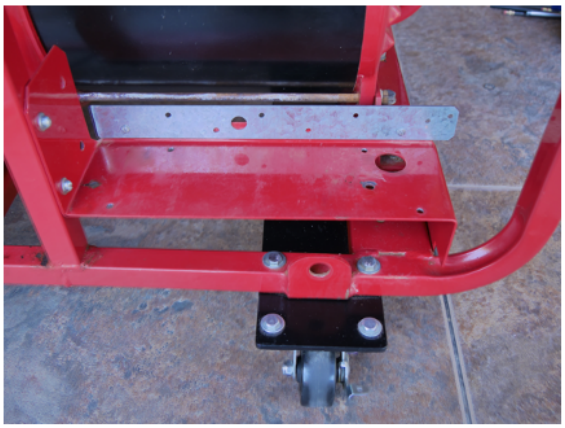
Motorcycle and garden batteries: Usually cannot deliver sufficient power for repeated starting attempts. They also have very short warranties—often only 90-days. The solution is to consider a vehicle battery. The warranty on most car batteries these days ranges from 24-36 months and has at least several hundred cold crank amps of power.

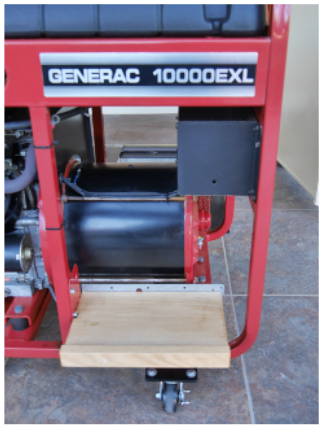
Float charger: When not in use, use a float charger to keep your battery fully charged. They usually cost less than $10, use negligible electricity, and they can be kept on the battery indefinitely. I keep one on my mowing machine year-round. The garden battery on that machine is almost 7 years old and still works. But: Do **not** use a trickle charger. It can overcharge you battery and ruin it. Use a **float** charger.

Also: Never jump start a generator from a vehicle with the vehicle running. Vehicle alternators typically put out *very* high amperage and a home generator's charging circuit often cannot handle it. It may be damaged. If you need to jump start your generator, do it with the vehicle's engine *off.*

Last bullet: Even if your battery is a "no maintenance" type, if the cells have removable lids, periodically use a putty knife, pry them off, and fill as needed, using distilled water.

Enlarging the Battery Shelf to Accommodate Larger Batteries





81

So, what do you do if the generator doesn't have room for a car battery?

Make room.

My existing battery shelf was too small to accommodate a vehicle battery, so I fabricated this from a Simpson framing strap and scrap wood.

This shelf was specifically made to accommodate Group Size H5 batteries—which is what my vehicles use. I can thereby use either car battery to start my generator. The curbs on the shelf assure that the battery will remain locked in place even without using a hold-down strap (although I designed the plate so a strap can be easily attached).

Ways to Minimize Problems and Improve System Reliability Part 2

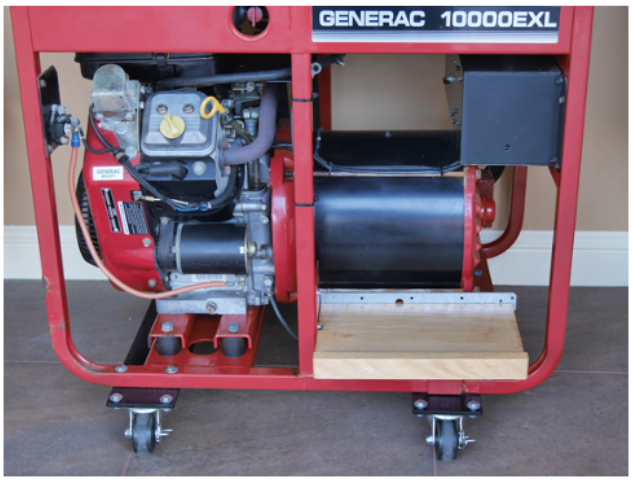
- Audible "power restored" notification device
- Hour meter retrofitting
- Wheel upgrades
  - If you're not transporting your generator to different sites, you're typically moving the generator just a few feet
  - Suggestion: Four solid caster wheels with a 360 swivel and foot-control locking lever

82

The first two bullet points have already been discussed and are shown just for inclusiveness.

Wheels: If your portable generator is only used for power outages, you'll probably only be moving it a short distance. Gen-sets are heavy. With most portable gen-sets, you have to lift one end, about half the entire weight, to move it.

360-Degree Swivel Caster Wheels

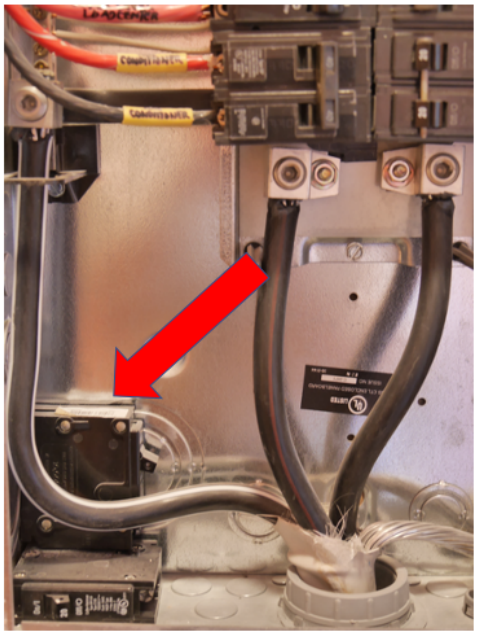


Four Pack: Caster Wheels. Swivel Plate with Brake.
3-inch Red Polyurethane Wheels
250 lb. load rating per wheel
Double ball-bearings, non-marring, and abrasion resistant.
$22.99 Amazon (also available in 4 and 5 inch sizes)

83

Here's a solution: 360 degree swivel casters with foot-locks. You're no longer lifting—you're just pushing. Our generator weighs around 260 lbs. My wife can move it with one hand. Yet, when the wheels are locked, no amount of engine vibration can move it.

The poly caster wheels shown at the right are far better than mine. Each wheel supports 250 lbs., has double ball bearing construction, and is non-marring and abrasion resistant.



Keep Spare Parts Handy

84

Ideally, keep spare parts as close as possible to where you may need them. For example, shown here, on the lower left, I keep some spare circuit breakers within each of my loadcenters.

Ways to Minimize Problems and Improve System Reliability - Part 3

- Have spare fresh oil and generator wear parts, on hand:
  - Oil filter, air filter, spark plugs, fuel filter…
  - Keep a few extra circuit breakers on hand—especially 15 and 20A
  - Try to use the same loadcenter manufacturer for all loadcenters so you only need stock up on the circuit breakers of one manufacturer
- Fuel gauge - It's not easy to retrofit a fuel gauge, so make your own calibrated "fuel dipstick" (See addendum slide)

85

One of the takeaways from this slide is standardization. All 5 of my loadcenters are Cutler-Hammer and of the same vintage. Any of my breakers can therefore be used in any of my loadcenters.

Consider Weather Protection Options

Note: This product is not made to protect the generator from flying embers

- Gentent 20K Stormbracer Extreme with direct connect kit for open frame generators over 10Kw. Maintains airflow. Stable in up to 70 mph wind.
- UV treated. Sheds rain, snow, ice, and sleet. 3 yr. warranty. US made. $200

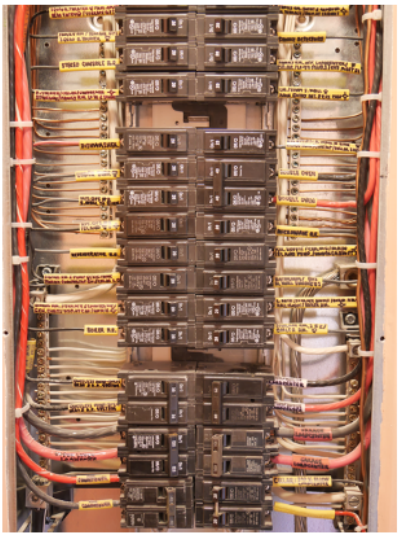
86

Again: Moisture and electricity don't get along. This is one way to protect a portable generator in inclement weather. This company, Gentent, makes covers in a number of sizes and in two different quality levels. This is a large tent in their "extreme" line covering the Caterpillar generator I showed earlier.

Assembly is quick and easy. First, outriggers affixed to the cage are folded down and locked into a horizontal position. Then flexible rods affix to the outriggers. The tent cover drapes over the rods. The lower part of the cover is clear colorless plastic that allows one to view the generator's control panel. They maintain airflow, are UV treated, and can withstand up to 70 mph winds.

Also UV, water-resistant, generator storage covers are available in various sizes that simply drape over the unit. Some are cotton-lined to prevent abrasions. For example, WEN makes a large one that sells for $20 through Home Depot.

Loadcenter Labeling

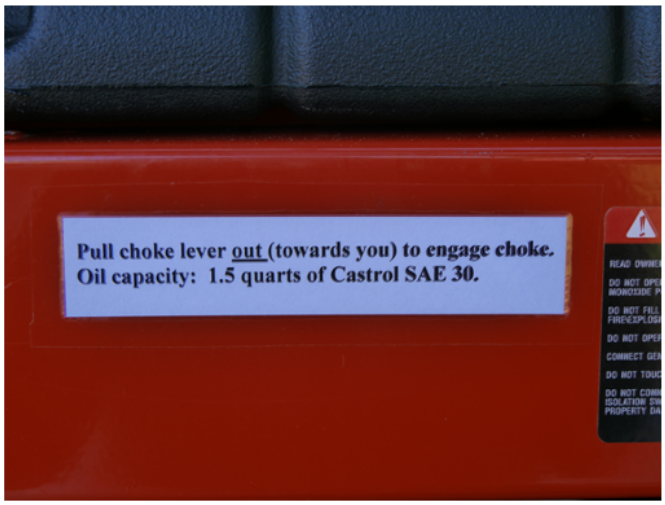


87

Always clearly label *all* wiring, *and demand it of anyone who works on any wiring in your home*-- not just generators and loadcenters. So, I'm talking alarm system, landline phone system, fiber optic or cable Internet router wiring, all CAT5e & CAT6 cables —you name it. It can save a lot of angst. (Shown is my personal version of what I feel a properly-labeled loadcenter should look like.)

This is important so that not just you, but your family, knows how these systems work and can easily figure things out—especially during an emergency.

Labeling Generator Operations



88

This is, once again, about labeling. In many gen-sets, the choke position is not intuitive. And even if you know it from day one, other people who may have to use your generator may not.

The photo on the left shows my choke control lever (the cadmium-plated rod with the circular ring at the end just to the right of the valve cover). One often has to remove the air filter to see the choke, and, in many generators, like mine, that means first removing the fuel tank. Better solution: Label it (as shown on the right photo).

Ways to Minimize Problems and Improve System Reliability - Part 4

- Theft suggestion: Secure portable generators to an immovable object with a cable lock or similar
- Standby generators: If the power situation degrades to where you experience quick on-and-off power failures just seconds apart: Set the standby power delay to at least 30 seconds or serious damage may result
- Complexity: Some pros warn against purchasing a highly electronic or computerized generator due to reliability issues
- Consider purchasing a generator with a credit card that may extend your warranty coverage.

89

With respect to the bullets shown:

Theft: I think we've seen enough posts on Nextdoor Occidental to know it's unfortunately necessary to secure your generator.

Power fluctuations: For those people with automatic transfer switches: If PG&E's power should rapidly start cycling on and off, you need to immediately lengthen the delay time on the switch to avoid ruining your generator.

Complexity: The mantra of some pros is that the simpler and more mechanical the generator, the better. I feel there's some merit in that. As I've mentioned, heat and/or moisture can ruin electronics—and both are present in most generator environments.

Warranty issue: I feel a generator needs to be used for **at least** 100 hours or so to be reasonably assured that any slowly developing problems have manifested themselves. However, for most of us, our generators will only be used sporadically. If using your credit card will extend the warranty, I advise taking advantage of it.

System Maintenance

- **Most importantly**: Follow the owner's manual instructions and record all maintenance performed—*in the manual*.
- Photocopy the owner's manual
  - Keep the photocopy by the generator and the original on file
- Label the gas container with the date and note when a stabilizer was added
- Gas quality
- Fuel additives

90

Gas quality: Gas quality has degraded substantially over the years. Octane ratings have lowered while ethanol content, the nemesis of small engines, has risen. The closest place one can obtain ethanol-free gas is in Cloverdale. Small engine shops therefore advise using only premium quality gas—ideally Chevron Supreme—along with a fuel stabilizer. But first, contact the manufacturer to assure the stabilizer is compatible with the generator.

System Maintenance (cont.)

- Fuel: To drain… or not to drain?
- Clean air filter at completion of generator use
- Oil and oil filter changes
- Spark plugs: Inspect, clean, and check gaps
- Spark arrestor cleaning: Use a non-metallic brush, like a toothbrush or small nylon detail brush
- Plastic and rubber protectant application
- Periodically check tightness of bolts and screws

91

With respect to the bullets shown:

Stale gasoline is a big problem. There are two schools of thought. Some suggest keeping the gas tank full to avoid condensation. Others suggest draining the tank to avoid varnish buildup in the carburetor.

I didn't think condensation would be an issue in our area. I was wrong. I experimented and discovered that overnight changes of a mere 20-25 degrees produced substantial fuel tank condensation. On the other hand, varnish buildup may require rebuilding your carburetor.

I therefore suggest adhering to the manufacturer's instructions for long-term storage.

Also:

Fuel line shutoff: Shut off fuel line after each use. Place note atop generator when the fuel line has been shut off and include the last day you used the generator.

Air filter cleaning: Do at completion of generator use, not before using it. That way you always have a clean filter ready for the next outage.

Oil and oil filter changes (esp. for initial break in period): I suggest changing oil in a new machine, while still hot, after the first 3- 5 hours of use, and then following the suggested maintenance schedule.

It's a good idea to check the gap on new plugs.

Spark arrestor cleaning: Many people do this with a wire brush. Wrong. Use a non-metallic brush, like a toothbrush or small nylon detail brush. Wire brushes score the metal screen and accelerate carbon buildup. Cleaning will prevent clogging and may improve engine performance. (Continued next page.)

And last: Periodic application of a protectant to the plastic and rubber parts will help minimize ultraviolet degradation.

With proper maintenance, if used sparingly, with breaks in between usage, a typical, quality, portable gasoline-powered generator should last around 3,000-5,000 hours. These are 3600 RPM generators are typically not overhauled.

A well-maintained standby generator should last around 15,000 hours. Only 1800 RPM standby generators over 20kW warrant overhauling. (

The End

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I hope this information proves useful to you.

Thanks to all who helped in the compilation of this presentation.

Making Your Own Fuel Gauge

- Use a light-colored stick of softwood like fir, pine, or redwood
- Using a stopwatch, determine how long a full tank of fuel will last under your *typical* usage load
- With the next tank fill-up, mark the dipstick reading
- Take successive readings at 1 or 2 hour run intervals (depending on the total rated/running time) and mark those locations with hash marks
- Final mark should delineate the 1-hour remaining fuel point
- Label the marks indicating "remaining fuel hours" from top-to-bottom [Example: 7 hr. (full mark) , 5 hr., 3 hr., 1 hr.]

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Wire Size Selection for Long Cable Runs

Source: https://www.cerrowire.com/products/resources/tables-calculators/voltage-drop-tables/

To determine the current load, add up the wattage of all electrical devices that will be on the circuit and divide the total by the circuit voltage, usually 120 volts or 240 volts.

120 Volt Conductor size (AWG or kcmil). Single Phase. Max 3% Voltage Drop*						
Length of run:	25'	50'	100'	150'	200'	
Copper	14	12	10	8	6	15 AMP**
Copper	12	12	8	6	4	20 AMP**
Copper	10	10	6	4	4	30 AMP**
Copper	1	1	1	2/0	4/0	100 AMP**
Aluminum	1/0	1/0	2/0	4/0	300	100 AMP**
Copper	3/0	3/0	3/0	300	500	200 AMP***
Aluminum	250 MCM	250 MCM	300 MCM	600 MCM	900 MCM	200 AMP***

AMP**Copper121286420 AMP**Copper101064430 AMP**Copper1112/04/0100

AMP**Aluminum1/01/02/04/0300 MCM100 AMP**Copper3/03/03/0300 MCM500 MCM200

AMP***Aluminum250 MCM250 MCM300 MCM600 MCM900 MCM200 AMP***

Wire Size Selection for Long Cable Runs

Source: https://www.cerrowire.com/products/resources/tables-calculators/voltage-drop-tables/

To determine the current load, add up the wattage of all electrical devices that will be on the circuit and divide the total by the circuit voltage, usually 120 volts or 240 volts.

240 Volt Conductor Size (AWG or kcmil). Single Phase. Max 3% Voltage Drop*						
Length of run:	25'	50'	100'	150'	200'	
Copper	14	14	12	10	10	15 AMP**
Copper	12	12	12	10	8	20 AMP**
Copper	10	10	10	8	6	30 AMP**
Aluminum	8	8	8	6	4	30 AMP**
Copper	8	8	8	6	4	40 AMP**
Aluminum	6	6	6	4	3	40 AMP**
Copper	6	6	6	6	4	50 AMP**
Aluminum	4	4	4	4	2	50 AMP**

*The tables assume steel conduit, a power factor of 0.9, an ambient temperature of 86°F, and no more than 3 current-carrying conductors.
**Based on 60°C per NEC 110.14(c)(1)(a).
***Based on 75°C per NEC 110.14(c)(1)(b).