Fire, Safety and Health
Tech Tips

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Safe Use of Small Generators

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Small generators frequently are used in remote sites and temporary camps to power lights and small electrical and electronic devices. Powered primarily by gasoline or diesel, and rated for outputs from less than 1,000 watts (1 kilowatt) to as high as 10,000 watts (10 kilowatts), small generators can be extremely handy in providing electrical power for lights, computers, small tools, heaters, and many modern conveniences in remote locations. A few basic safety precautions must be taken when working with and around small generators. Even the smallest generator can produce enough power to severely injure or kill an unwary user. Fuel that is mishandled can cause injury and death.

This tech tip provides basic guidelines for safe operation of small gasoline-powered generators, regardless of brand or local codes. If you have questions about using any electrical device, always consult a licensed electrician.

Highlights...

- Before being operated, all generators, regardless of size, need to be connected to a proper ground.
- Ground fault circuit interrupters detect short-circuited electrical power, but don't provide protection against circuit overloading.
- Load calculations help determine the size of generator that will meet your electrical needs safely and reliably.

Basic Safety

The operator's manuals for every generator include a list of basic safety dos and don'ts. While these lists may vary slightly from one manufacturer to another, the following list includes common concerns:

NEVER

- Operate a generator inside any enclosed space, including inside a tent.
- Fuel a generator while it is running.
- Smoke while handling fuel.
- Overfill the fuel tank—always leave space at the top of the fuel tank for the fuel to expand.
- Operate a generator in the rain.
- Operate a generator while you are barefoot.
- Operate a generator while you are in water or the generator is in water.
- Start a generator that has any electrical load connected to it.
- Overload a generator.
- Operate any machinery while you are physically or mentally tired.
- Use a generator as a step or set objects on top of it.
- Connect a high-amperage load to a low-amperage circuit.
- Move a generator that is running.
- Use frayed or damaged extension cords, or any appliance with questionable wiring.

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ALWAYS

- Follow all manufacturer's instructions before and during use.
- Ground all generators before use.
- Allow 2 feet of space all the way around the generator while it's in use.
- Use properly rated cords for the loads used.
- Turn off the generator and allow it to cool before performing any maintenance or fueling.
- Test the ground fault circuit interrupter (GFCI or GFI) receptacle before use.
- Keep an ABC-rated fire extinguisher nearby when operating a generator.

If you are using a small portable generator as a backup power source around a home or office, ***NEVER*** connect the generator into the building wiring unless it is through a transfer switch specifically designed to allow the use of a backup generator. If a transfer switch isn't available or you're in doubt, ***ALWAYS*** plug the loads directly into the generator itself. Plugging the building or its power system into the generator without the proper wiring could injure or kill power workers miles away.

Grounding

The National Electrical Code (NEC), and many local codes, require that all generators be connected to a proper ground before being operated, regardless of the generator's size. A proper ground can differ from location to location because of different soil types and the varying effectiveness of ground rods. A proper ground can be as simple as a grounding rod pounded into the ground or may be much more elaborate.

Ground Fault Circuit Interrupter (GFCI or GFI)

The GFCI or GFI detects when electrical power is being short-circuited directly to the ground. The interrupter opens a switch, halting the flow of electricity. If the cause of the short circuit is a human providing a path to ground, the GFCI should minimize any injury.

The GFCI does not provide protection against circuit overloading—that's the job of a circuitbreaker.

For the GFCI to operate as intended, the generator must be properly grounded. The GFCI can be tested by pressing the *Test* button on the outlet. If the button does not trip the GFCI, the most likely problem is an inadequate ground connection.

Operation

Before starting the generator, be sure that it has enough capacity for your intended load. Do load calculations before starting the generator. For example, a single string of ten 100-watt light bulbs will place at least a 1-kilowatt load on the generator. If you are using a 1-kilowatt generator, you might overload it and you certainly will not be able to connect anything else.

Always plan for more generator capacity than your electrical need. If calculations indicate you are nearing a generator's maximum load, use additional generators or plan to establish a more robust source of power.

Always unplug all loads before starting a generator for the first time or when restarting one after servicing. Once the generator has started, allow it to warm up and stabilize for a few minutes before plugging it in and operating loads. Always plug in loads and turn them on one at a time. Allow the generator a few moments to stabilize before adding another load.

Shutting down the generator requires the same consideration. Turn off and unplug loads one at a time before shutting off the generator. The generator and the loads connected to it may be damaged if the generator is allowed to run out of fuel, or is shut off while it is providing full power to the loads.

Extension Cords

Here are some dos and don'ts regarding the use of extension cords.

DO

- Use the shortest cord needed.

DO NOT

- Use damaged or pinched cords. Even a heavy-duty 100-foot 12/3 American Wire Gauge (AWG) cord that technically should be able to handle a full 1.8-kilowatt load may overheat if the cord is damaged or pinched. The wire could melt and the damage could cause a fire.

- Use a tightly coiled cord near its full capacity. Cord capacities are calculated on the assumption the cord is laid out straight and can get adequate cooling. Tightly coiling a cord, especially on a reel, prevents the cord from cooling off. The insulation may melt and the damage could cause a fire.

Cord length (feet)	Gauge	Maximum amperes
50	18	5
50	16	10
50	14	15
100	16	5
100	12	15
150	16	5
150	12	13

Basic Electrical Calculations

The easiest and most widely used calculations are:

$$A = W/V \quad \text{and} \quad W = A \times V$$

Where V = Voltage
W = Watts
A = Amperage

Appliances usually have the required current (amperage) listed somewhere on them. To calculate load, add the amperages of everything to be powered and multiply by 120 (the standard voltage in the United States). The result will be the minimum power needed in watts.

Example: To calculate the power for three appliances and a string of five 100-watt lights, first consider the power needed for the appliances. If the three appliances draw a total of 12.5 amperes, you will need 12.5 x 120 = 1.5 kilowatts of power for them. The lights will need 500 watts of power. A total of 2 kilowatts is needed. Never expect a generator to power its maximum load because the listed load capability is for a new generator in perfect working order. Age, wear, and other factors may reduce the power available, so it would be wise to order a 3-kilowatt generator for a 2-kilowatt load or to drop one of the items from the load.

Starting Electric Motors

When you are using a generator to power devices with electric motors (air conditioners, compressors, fans), an additional factor needs to be considered. The load rating for a motor is the load when the motor is in normal operation. Electric motors draw much more power when they first start. Each motor is different. The more resistance a motor has to starting, the more power it will need. It is important that the generator have enough capacity to cover this load at startup. Three times the rated wattage is a good rule of thumb. So if a motor is rated at 500 watts, the generator needs to be able to provide 1.5 kilowatts at startup.

Generator Outlets

The typical small generator has several different outlets on the outlet panel. Figure 1 shows a typical generator available from a fire cache. Figure 2 is the panel showing the controls as well as the outlets. There are several configurations of plugs and receptacles. Typically, most uses of the generator include the standard 20-ampere, grounded, three-prong plug found in most households. However, the round locking three-prong plug (20- or 30-ampere rating) seen in figure 2 may be used. Always use the proper wiring and the proper plug for the power that is needed.

Figure 1—A small portable generator.

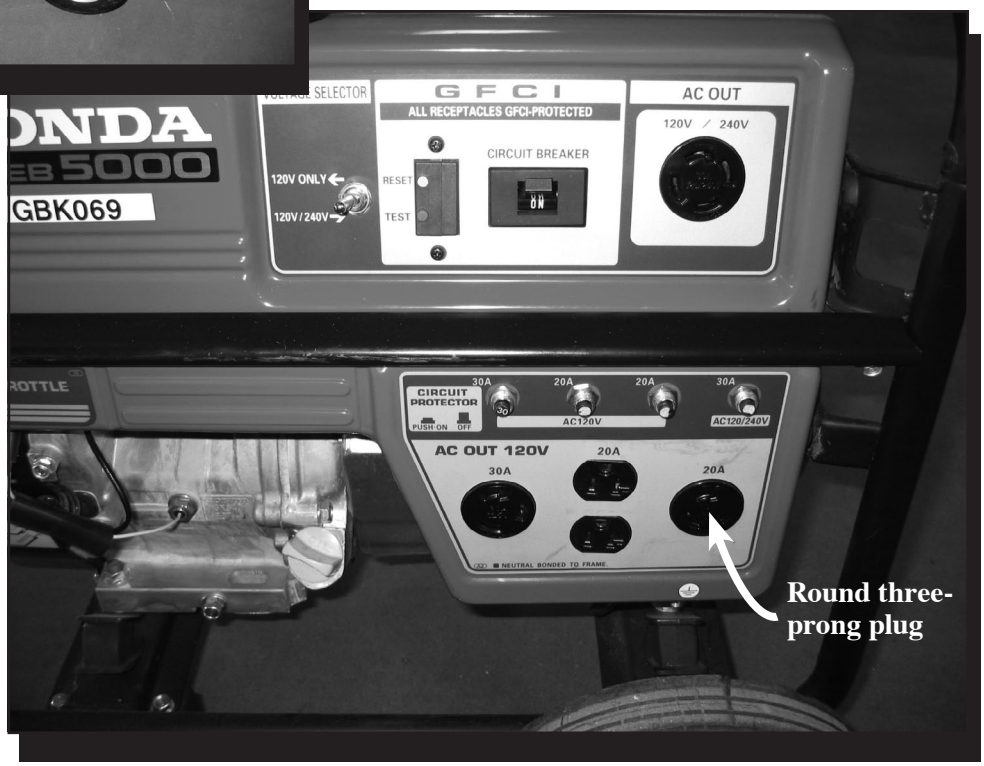

Figure 2—The control and outlet panel on a small portable generator.

About the Author

Dennis Davis received his engineering degree from the University of Oklahoma in 1978. He was a drilling engineer for many years and was a specifications engineer for the General Services Administration until 1998 when he joined MTDC. Davis is the specifications engineer for wildland firefighting equipment. He also is a volunteer firefighter, emergency medical technician, and battalion chief for the Frenchtown, MT, rural fire district.

Library Card

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Provides safety guidelines for operating a small generator. Explains how to calculate loads when selecting a generator so it will have the capacity required for specific electrical needs. Includes safety information on ground fault interrupters, extension cords, and generator outlets.

Keywords: amperage, amps, capacity, electricity, GFCI, GFI, kilowatts, load rating, safety at work, voltage, watts

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Single copies of this document may be ordered from:

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