Generator Handbook

MULTIQUIP®

Introduction

One of the most basic necessities on a jobsite is the need for portable power. The demand for clean, reliable power has made Multiquip generators the most highly regarded brand in the equipment industry.

This handbook will cover basic electrical terminology and provide you with the necessary guidelines to help properly size a generator.

Basic Electricity

A generator converts mechanical energy into electrical energy.

Electricity is commonly described in terms of voltage, amperage and watts:

- **Voltage** — The electrical pressure, or force, that causes current to flow in the circuit.
- **Amperage** — The amount of electrical charge, or current, flowing in the circuit.
- **Watts** — A measure of electrical power.

Voltage can be compared to the flow of water. There must be a difference in pressure in order for water to flow from one location to another.

In an electric circuit, if there is a pressure (voltage), and path provided, then electricity will flow (current) through the conductor. Voltage is the force that causes electricity to flow through wires, while current is the movement of electricity.

Direct Current

Direct Current (DC) is an electrical charge that flows in one direction through a circuit (figure 1). It is commonly used in consumer goods such as radios and automobiles. Dry cells and batteries are some other common sources of direct current.

A direct current source is marked with plus (+) and minus (-) symbols that indicate the direction of current flow in the circuit. The theory behind direct current holds that it flows from the positive (+) terminal, through the circuit and returns to the negative (-) terminal of the power source.

Alternating Current

Alternating current (AC) changes its direction of flow at regular intervals and is found in all residential, commercial and industrial applications.

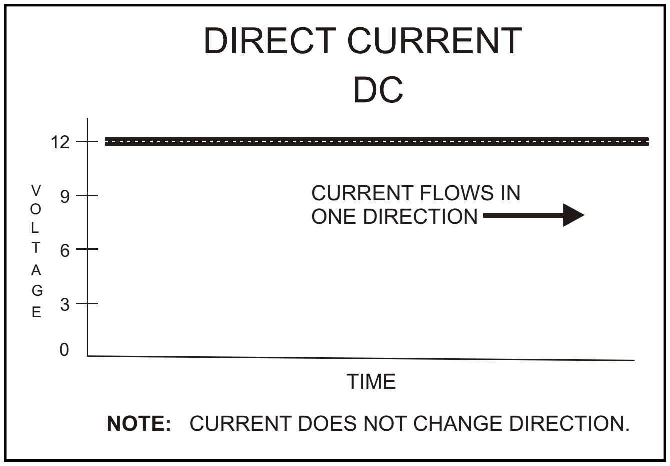

Figure 1 — Direct Current (DC)

Utility companies generate electrical power at several thousand volts and send it hundreds of miles. It is converted to higher and lower values through transformers.

Frequency

The rate at which alternating current changes direction determines its frequency. Each time the current goes one way and then the other way is called a cycle. Frequency is the number of cycles that occur in a single time period.

Frequency is also commonly referred to as Hertz (Hz) or CPS (cycles per seconds). One Hz is equal to one CPS. In the United States standard household current is 60 Hz while many foreign countries use 50 Hz current.

In the construction industry 180Hz “high-cycle” current is used to power certain concrete vibrators. Some aircraft and ships use 400Hz power. Figure 2 illustrates the relationship between alternating current and frequency.

Multiquip GDP5H 60/180 Cycle Generator

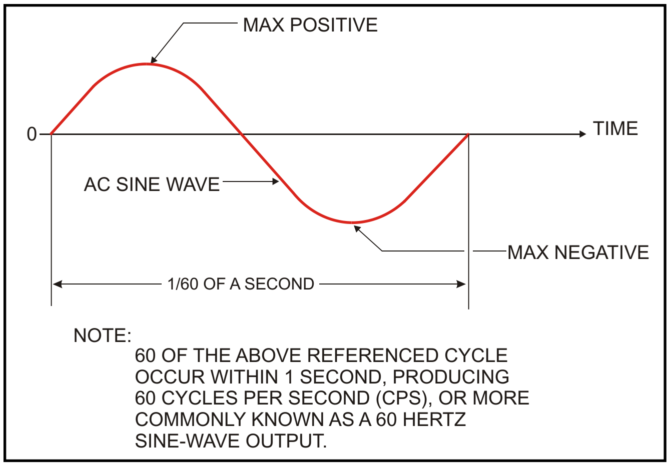

Figure 2 — Alternating Current (AC) and Frequency (Hz)

Phase

Phase is a term applied to designate the circuits of an AC system. In the single-phase system, the voltages are in the same time phase in all parts of the system. In the three-phase system, the voltages are 120° apart.

Single-phase power (figure 3) can be transmitted by either a two-wire circuit or a three-wire circuit. The single-phase two wire method is the simplest and most commonly used. The voltage associated with this method is 120 VAC and is used to supply lamps, small motors, hand tools and appliances.

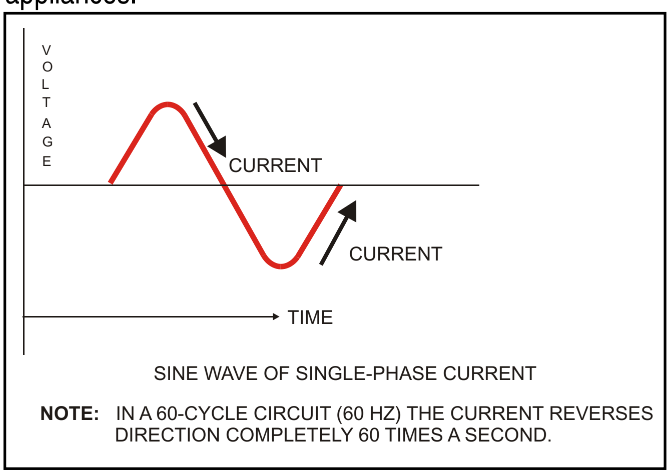

Figure 3 — Single phase power

The single-phase three wire circuit is really two single-phase circuits with one wire in common. The voltage associated with this method is 240 VAC. This application is used where more power is required can can be supplied by the two wire system. Multiquip GA-Series generators produce this type of single-phase power.

Three-phase power (figure 4) is transmitted by three hot wires with one ground. It is more versatile than single-phase power and is commonly used in industrial and commercial applications. One reason for this is a three-phase motor

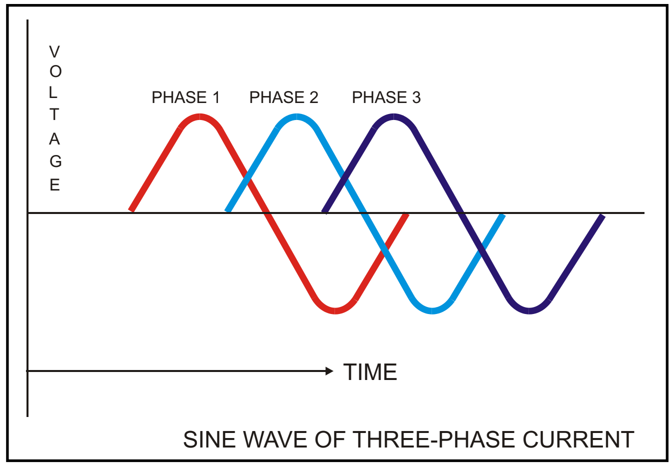

Figure 4 — Three phase power

is easier to start and more efficient than a single-phase design. It is not used in residential applications.

Construction equipment typically uses either single phase or three phase motors. The contractor should specify the phase required for the job. MQ Power has a full line of generators that provide both single and three-phase power.

Output

Gasoline-powered portable generators are rated in terms of maximum and continuous output.

Maximum output is the total wattage put out by the generator over a short period of time. Once the generator has been running for about 5 minutes the heat created by the machine will lower its electrical output.

Continuous output refers to the total wattage put out by the generator over a long period of time. Frequently referred to as rated output, it takes into account the effects of heat on generator efficiency. When sizing a generator, continuous output is more important than maximum output.

There is also a difference between starting amperage and running amperage. **Starting amperage** is the amount of amps required to start an electric motor. **Running amperage** is the amount of amps required to continuously run a motor.

Generator Sizing

The first thing you will need to do is determine what type of load your customer will be using with the generator. There are two types of loads ***resistive*** and ***inductive***.

Resistive, *or reactive, loads are devices that use a heating element and require the same amount of power to start as to run. Examples include light bulbs and appliances such as heaters, toasters, irons and skillets.*

__Inductive__, or capacitive, loads are devices that use an electric motor and require more wattage for start up than continuous operation. Examples of inductive loads include concrete mixers, submersible pumps and air compressors.

Next, ask your customer to provide you with the voltage, amperage, and wattage of the tools that will be run off the generator. With this information you can easily determine the total wattage requirement of the equipment being used. This is accomplished by using the power formula.

Power Formula

Use this formula to size a generator to fit your customer's needs.

Volts x Amps = Watts

The following example explains how to apply the power formula.

A customer calls looking for a generator to power a heater at his jobsite. Simply ask what the voltage and running amperage is and insert them into the formula. So, if he has a 120-volt heater that draws 4 amps . . .

120 **Volts** x 4.0 **Amps** = 480 **Watts**

You have determined that the heater will need 480 watts to operate. In this application the smallest Multiquip generator (GA2H5) would adequately fit his needs.

Multiquip GA25H 2.5kW Generator

When sizing a generator, select a unit that has a continuous output equal to or greater than the total wattage requirement of the equipment. It is often a good idea to provide a little more power than what is actually required. This will give the contractor a little more versatility once he arrives on the jobsite. Often the customer may need to run more equipment than initially expected and will appreciate the extra power.

Sizing With the One-Two-Three Method

Multiquip GA36HA 3.6kW Generator

One – Use this method exclusively with resistance loads (heaters, light bulbs, toasters etc.). Simply total the wattage of all the items being powered by the generator. For example, let's say you have a total of 29 light bulbs rated at 100 watts each. The total wattage is 2,900 watts (29 x 100 = 2,900). Select a GA36HA generator which puts out 3,200 continuous watts.

Two – For items such as drills and other power tools, take the total wattage and multiply it by two. These tools will typically require up to twice the power to start than run under load. As an example, it takes 1,300 watts (1.5KW) to run a 7¼" circular saw. Multiply the running wattage by two in order to obtain the total wattage (in this case 2,600 watts). Again, you would need a GA36HA generator.

Three – Equipment with bolted down motors (mixers, compressors etc.,) running wattage is generally multiplied by three. Some equipment such as submersible pumps may even require up to seven times the running amperage to start!

Note: The appendix of this handbook contains several charts to help you determine the wattage requirements for contractor and homeowner applications.

Altitude and Temperature

Altitude and temperature can have adverse effects on generator output. Let's begin by looking at the effects of altitude. Gasoline powered gensets will decrease by 3.5% in power for each 1,000 feet of elevation above sea level.

Example: A 6 KW generator in Denver, CO
5,000 ft. elevation
3.5 x 5 =17.5% decrease
Maximum output is now 4,950 watts.

High temperatures can also decrease the efficiency of your generator by 1% for each 10° above 60° Fahrenheit.

Example: A 6 KW generator in Phoenix, AZ
It's Labor Day weekend; the temperature is 120°
120° - 60° = 6 x 1 = 6% decrease
Maximum output is now 5,640 watts.

Now let's see what happens when you combine high altitude and high temperature.

Example: 6 KW Generator in Denver, Colorado
Elevation: 5,000 ft. elevation
Temperature: 100° Fahrenheit.
Altitude: 3.5% x 5 =17.5% decrease
100° - 60° = 4 x 1 = 4% decrease
Total decrease = 21.5%

Maximum output is 4,710 watts.

Electrical Safety

"Safety is everybody's business," so the old saying goes. This has probably never been truer than it is in today's workplace. The rise in court cases involving accidents on the job has grown steadily in recent years. Many of these unfortunate accidents could be avoided by having a staff that is properly trained and capable of educating the customer on the potential hazards of operating a piece of equipment.

Following are some basic tips for safe operation. Please take the time to read your operator's manual before using your generator.

Always remember a generator is a source of high, and potentially lethal, voltage. Never permit unqualified people—especially children—to operate a generator.

GA-Series generators are equipped with a ground fault circuit interrupter (GFCI) on their duplex 120V receptacle. A GFCI protects the tool operator by reacting to leakage current in excess of 5 milliamperes. It should be understood that they do not eliminate the risk of shock or electrocution. By design they will reduce the duration of an electrical shock and minimize the risk of electrocution

All Multiquip generators are equipped with a grounding terminal located on the base of the machine. This enables the operator to provide the machine with a proper earth ground. A copper rod must be driven 8 feet into the ground and attached to the lug with a wire having a minimum size of #8. If possible, complete the ground from the generator to the building's ground source.

Never operate the generator or handle any electrical equipment while standing in water, while barefoot, with wet hands, or in the rain. Doing so could result in serious injury or death.

Never provide a unit to a customer if it is not working properly. Maintain electrical cords in good condition and check for worn, bare or frayed wiring. If a problem is found, immediately tag the machine and return it to your service department for inspection.

Never operate the generator set in an explosive atmosphere or near combustible materials. An explosion or fire could result.

Always ensure the generator is operated in an area with adequate ventilation. Gasoline engines consume oxygen and produce **DEADLY** carbon monoxide fumes.

Please exercise common sense when operating a generator. Only a qualified electrician should perform any electrical wiring.

Too often the decision to buy a generator is based solely on the engine used to turn the alternator end. In a market flooded with look-alike generators powered by similar engines it becomes difficult to decide on the best generator for the job.

Remind your customer that all generators are not created equal and cover the features and benefits so the customer is informed before making their decision.

What Makes A Good Generator?

Multiquip GA6HA 6kW Generator

Appendix A — Electric Motors *Approximate wattage requirements*

		STARTING WATTS			
HORSEPOWER	RUNNING WATTS	UNIVERSAL MOTOR (SMALL APPLIANCE)	REPULSION INDUCTION MOTOR	CAPACITOR MOTOR	SPLIT PHASE MOTOR
1/6	275	400	600	850	1200
1/4	400	500	850	1050	1700
1/3	450	600	950	1350	1950
1/2	600	750	1300	1800	2600
3/4	850	1000	1900	2600	X
1	1000	1250	2300	3000	X
1-1/2	1600	1750	3200	4200	X
2	2000	2350	3900	5100	X
3	3000	X	5200	6800	X
5	4800	X	7500	9800	X

X =This type of motor is not normally used in this power range. For larger motors watts = hp x 932

NOTE: For pumps, air compressors, air conditioners, add at least 25% to starting wattage.

Appendix B — Extension Cord Gauge

Extension cords also present another factor that should be considered when sizing a generator. Cables should be sized to allow for distance in length and amperage so that the voltage drop between the generator and point of usage is kept to a minimum. Use the chart below as a guide for determining the proper size and length of insulated copper wire extension cord.

AMPERES	WATTS		MINIMUM GAUGE (AWG)		
	@120 VOLTS	@240 VOLTS			
2	240	480	22	20	18
3	360	720	22	18	16
4	480	960	20	16	16
5	600	1200	18	16	14
6	720	1440	18	16	14
8	960	1920	16	14	12
10	1200	2400	16	12	12
12	1440	2880	16	12	10
14	1680	3660	14	12	10
16	1920	3840	14	10	10
18	2160	4320	14	10	8
20	2400	4800	12	10	8
22	2640	5280	12	10	8
25	3000	6000	12	10	6
30	3600	7200	10	8	6
35	4200	8400	10	8	4
40	4800	9600	8	6	2
50	6000	12000	6	4	2
60	7200	14400	4	2	

Appendix C — Reference Chart for Construction Applications

	WATTAGE REQUIREMENTS*	
	STARTING	**RUNNING**
Concrete Vibrator - 3/4 hp	1900	850
Concrete Vibrator - 1 hp	2500	1100
Concrete Vibrator - 2 hp	3600	1800
Concrete Vibrator - 3 hp	4800	2400
Drill - 1/4"	400	300
Drill - 3/8"	650	475
Drill - 1/2"	900	750
Drill - 1"	1250	1000
Floodlight	--	1000
Heat (radiant, portable)	--	1300
Heater (portable, liquid fuel) - 50,000 BTU	675	225
Heater (portable, liquid fuel) - 100,000 BTU	1260	420
Heater (portable, liquid fuel) - 150,000 BTU	1875	625
Impact Wrenches - 1/2"	750	600
Impact Wrenches - 3/4"	900	750
Impact Wrenches - 1"	1400	1200
Mixer, 3-1/2 Cubic Feet	2300	1000
Motors – Refer to Appendix A		
Sander, Belt	2600	1200
Sander, Disc	2600	1200
Sander, Orbital	2600	1200
Saw, 6" Circular	2200	950
Saw, 7-1/4" Circular	2600	1200
Saw, 8-1/2" Circular	3000	1500
Saw, 10" Circular	3900	2000
Saw, Jig	400	300
Saw, Cutoff	3500	2500
Screwdriver	800	550
Soldering Iron or Gun	--	150
Sump Pump**	1300	400
Water Pump (Submersible) - 3,000 gph**	1750	500
Water Pump (Submersible) - 5,000 gph**	2500	650
Water Pump (Submersible) - 10,000 gph**	3750	1000
Water Pump (Submersible) - 15,000 gph**	5000	1500
Water Pump (non-submersible) - 3,000 gph**	2250	600
Water Pump (non-submersible) - 5,000 gph**	2850	750
Water Pump (non-submersible) - 10,000 gph**	4100	1100
Water Pump (non-submersible) - 15,000 gph**	5250	1600

* Estimated

** These items usually require slightly higher starting amperage.

Appendix D — Reference Chart for Residential Applications

	WATTAGE REQUIREMENTS*	
	STARTING	RUNNING
Air Conditioner**	3600	1300
Amplifier	200	200
Broiler	1400	1400
Blender	300	200
Clothes Dryer (gas)	850	400
Clothes Dryer (electric)	5700	5200
Coffee Maker	1000	1000
Dehumidifier	350	250
Edge Trimmer ½"	1050	850
Electric Blanket	200	200
Electric Range	1250	1250
Electric Skillet	1200	1200
Fan	135	100
Fan (attic)	450	375
Fan (furnace)	300	200
Fan (window)	300	200
Freezer	1200	325
Food Processor	450	300
Heating Pad	65	65
Heat Lamp (infrared)	250	250

	WATTAGE REQUIREMENTS*	
	STARTING	RUNNING
Hedge Clipper	200	120
Hedge Trimmer	600	450
Hot Plate (per element)	1250	1250
Humidifier	70	70
Iron	125	90
Juicer	125	90
Lawnmower	2500	1200
Lights, Incandescent (as indicated on bulbs)	-	-
Lights, Fluorescent (at stated on ballast)	-	-
Mixer (food)	300	200
Radio	125	2125
Recorder	40	40
Refrigerator	1200	330
Shaver	50	35
Sump Pump**	1300	400
Television (Color)	300	300
Toaster	1000	1000
Vacuum Cleaner	900	500
Washing Machine	1700	375

* Estimated
** These items usually require slightly higher starting amperage.

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