

Why Calculating Motor Starting Load Matters for Generator Sizing

When I first started helping friends pick generators for their workshops and homes, I made the same mistake almost everyone makes. I looked at the running watts on the motor nameplate and thought that was the number that mattered. It is not. The real challenge is starting the motor, and that means understanding how to handle inrush current. After years of watching people undersize their portable generator or struggle with a standby generator that trips on startup, I can tell you that calculating motor starting load is the single most important step in generator sizing.

A motor does not draw its rated running watts the instant you flip the switch. For a split second it pulls many times that amount, sometimes five to seven times the running watts. That surge is inrush current. If your generator cannot supply that surge, the motor will stall, the voltage will sag, and your generator may trip its breaker or even get damaged. That is why so many generator sizing guides tell you to start with the motor with the highest starting requirement. But you need to know how to find that number and what to do with it.

Backup Generator Guide 03 - SIZING

SIZING

Size from your actual loads

2-3 kW	Fridge · freezer · lights · internet · electronics
3-5 kW	+ furnace blower · sump pump · microwave
5 kW+	Compare against conventional portables

The watts-per-dollar gap gets big above 5 kW

because the watts-per-dollar gap gets big.

Understanding Inrush Current and Locked Rotor Amps

Inrush current happens because a stationary motor acts like a short circuit until it builds up back EMF. The technical term for the worst-case current during startup is locked rotor amps, or LRA. You will usually find the LRA value on the motor nameplate or in the manufacturer's documentation. If you see a number like 60 amps at 240 volts, that is the locked rotor current. Multiply that by the voltage and you get the peak starting watts. That peak is what your generator must handle, even if it only lasts for a few cycles.

For example, a 5 horsepower motor with a running current of 15 amps might have a locked rotor current of 75 amps. At 240 volts that is 18,000 starting watts. No wonder a small portable generator cannot start it. This is why [calculating motor starting load](#) is not just an academic exercise. It directly determines whether your generator will run that motor or not.

How Power Factor and Voltage Dip Affect Startup

Motors do not draw power at a perfect power factor. During startup the power factor can be very low, often around 0.3 or 0.4. That means the generator must supply much more apparent power than the real power the motor uses. A generator sizing calculator that ignores power factor will give you a false sense of security. You need to account for both real and reactive power.

Voltage dip is another practical concern. When a large motor starts, it can pull the voltage down across the whole circuit. If the generator has poor voltage regulation, lights may dim, other equipment may drop out, and the motor itself may not accelerate properly. Good voltage regulation is one reason inverter generators often handle motor starting better than conventional portable generators of the same wattage rating. An inverter generator can maintain tighter voltage control, which helps the motor start more reliably.

NEMA Designations and Motor Starting Capacitors

Motors built to NEMA designations have standardized starting characteristics. A NEMA Design B motor, for example, has a higher starting torque than Design A. That higher torque usually comes with higher inrush current. If you are pairing a motor with a generator, knowing the NEMA designation can help you predict whether the motor will be hard to start.

Some motors include a motor starting capacitor to help with the initial surge. That capacitor stores energy and releases it during startup, reducing the peak current drawn from the generator. If you have a motor that is borderline for your generator size, adding a motor starting capacitor can sometimes make the difference. But it is not a cure-all. You still need to do the math.

Practical Steps for Calculating Motor Starting Load

Let me walk you through the method I use. First, find the locked rotor amps on the motor nameplate. If it is not listed, use the rule of thumb that the starting current is about six times the running current for single-phase motors and about four times for three-phase motors. Multiply LRA by the voltage to get the peak starting watts. Then add the running watts of any other loads that will be running at the same time. That total is your peak load.

Now compare that peak load to the generator's surge capacity, not its continuous rating. Most portable generator and standby generator manufacturers publish a surge rating that lasts for a few seconds. That is the number that matters. If your peak load exceeds the generator's surge rating, you need a bigger generator or you need to manage the starting sequence.

One practical trick is to start the largest motor first, before other loads are connected. That way the generator is not already carrying a load when it faces the big inrush. I have seen people get away with a smaller generator simply by sequencing their startups correctly.

Tools and Technologies That Help

If you are tired of doing the math by hand, there are generator sizing calculator tools online that account for motor starting requirements. The best ones ask for locked rotor amps or horsepower and voltage, then compute the required surge capacity. They also let you add multiple motors and non-motor loads. I have used several over the years, and they save a lot of guesswork.

Hardware solutions can also reduce the starting load. A soft starter gradually ramps up the voltage to the motor, reducing inrush current by as much as 70 percent. For larger motors on a standby generator, a soft starter can let you use a much smaller generator than you would otherwise need. Variable frequency drives, or VFDs, do something similar. They control the frequency and voltage during startup, effectively eliminating the inrush spike. VFDs are expensive, but for critical equipment they are worth it.

Even something as simple as a motor starting capacitor can help, though its effect is modest compared to a soft starter. The key is to match the solution to the problem. If you have one motor that is just barely too big for your generator, a capacitor or soft starter might save you from buying a bigger generator. If you have several large motors, you may need a VFD or a generator with better surge capability.

Real-World Examples from the Field

I once helped a friend set up a workshop with a table saw, a dust collector, and an air compressor. The saw had a 3 HP motor with a locked rotor current of 45 amps at 240 volts, so

about 10,800 starting watts. The dust collector was 2 HP with 30 amps LRA, about 7,200 starting watts. The compressor was 1.5 HP with 22 amps LRA, about 5,280 starting watts. If he started all three at once, the peak load would be over 23,000 watts. No portable generator was going to handle that.

Instead, we used a generator sizing calculator to figure the worst case: starting the saw while the dust collector was already running and the compressor was off. That gave a peak of about 10,800 starting watts for the saw plus 1,500 running watts for the dust collector, total 12,300 watts. A 15,000 watt surge rated generator from Generac handled it easily. We also added a soft starter to the compressor, which let us start it later without worrying about the surge.

On another job, a customer wanted a standby generator for a small farm with several irrigation pumps. The pumps had NEMA Design B motors with high starting torque. The locked rotor amps were listed clearly on the nameplates. After calculating motor starting load for the largest pump, we found that a 20 kW generator was adequate even though the running load was only about 8 kW. The surge capacity was the deciding factor. We used a Westinghouse unit with good voltage regulation, and it has been running for years without a hiccup.

National Electrical Code and Sizing Requirements

The National Electrical Code has rules about conductor sizing and overcurrent protection for motor circuits, but it does not directly tell you how to size a generator. However, the NEC does require that the generator be able to supply the starting current of the largest motor plus the running current of all other loads. That is essentially the same calculation. If you follow the NEC approach, you will end up with a generator that is large enough for the motor starting load.

One thing the NEC does well is to define how to calculate the full-load current for different motor types. Those tables are useful if you do not have the nameplate. For single-phase motors, the NEC tables give you the amps per horsepower at various voltages. Using that data, you can estimate locked rotor amps by multiplying by a factor of about six. It is not as accurate as the nameplate, but it is good enough for preliminary sizing.

Common Mistakes and How to Avoid Them

The most common mistake I see is people using the running watts from the generator's spec sheet and assuming that is enough. They buy a 5,000 watt portable generator thinking it will run a 5,000 watt motor, and then they wonder why the motor hums and trips the breaker. The second mistake is ignoring the fact that motors on different types of generators behave differently. Inverter generators, for example, often have better surge capability than conventional portable generators of the same wattage because they use advanced electronics

to handle inrush. Standby generators typically have the best surge ratings because they are designed for heavy motor loads.

Another mistake is forgetting about voltage dip. Even if the generator can supply the starting watts, if the voltage sags too much the motor may not start. Generators with poor voltage regulation are especially vulnerable. I always check the voltage regulation spec before recommending a generator for motor loads. A unit with less than 5 percent regulation is preferable.

Finally, do not overlook the effect of elevation and temperature. Generators derate at high altitude and in high temperatures. If you are sizing a generator for a mountain cabin or a desert workshop, you need to increase the calculated size by about 3 percent per 1,000 feet above sea level and another factor for heat. A generator sizing calculator that accounts for these conditions is very helpful.

Wrapping It Up

Calculating motor starting load is not complicated, but it does require a few specific pieces of information and a willingness to do the math. The payoff is that you will never be caught with a generator that cannot start your equipment. Whether you are outfitting a home workshop with a Honda portable generator, a commercial site with a Generac standby generator, or a farm with an inverter generator from Westinghouse, the same principles apply. Look up the locked rotor amps or estimate them, multiply by voltage, add any concurrent loads, and compare that peak to the generator's surge rating. Use tools like generator sizing calculator websites to double-check your work. And when in doubt, add a soft starter or a VFD to reduce the starting load.

I have seen too many people buy a generator twice because they guessed the first time. Do not be that person. Take the time to do the calculation right the first time. Your wallet and your peace of mind will thank you.