How to Properly Size a Diesel Generator for Essential Equipment

Sizing a diesel generator for essential equipment is more than picking a machine that matches a nameplate wattage. A generator that is too small will struggle to start motors and may trip breakers or damage sensitive gear. One that is oversized burns more fuel than necessary and runs inefficiently under light load. The goal is to find the size that handles your equipment's real-world demands, including the surge when motors start, while keeping the generator inside its efficient operating range.

This process involves a few straightforward steps that anyone planning a backup or primary power system can follow. The steps go beyond simple math; they require thinking about how your equipment behaves and what conditions your site presents. The payoff is a system that delivers reliable power for demanding sites without wasted capacity or unexpected failures.

Step 1: List Every Essential Piece of Equipment and Find Its Running Watts

Start by writing down every device, machine, or system that must keep running when the grid goes down or where no utility power is available. Essential equipment might include refrigeration units, lighting circuits, pumps, computers, communication gear, or production machinery. Do not guess; check the nameplate on each piece of equipment or its manual. For motors, look for the full-load amperage and voltage. Multiply volts by amps to get the running watts for resistive loads. For inductive loads such as motors, the nameplate often gives horsepower; one horsepower equals roughly 746 watts, but motor efficiency and power factor mean the actual running watts will be higher.

Be honest about what is truly essential. Every extra load you add increases the required generator size and the fuel you will burn. If a piece of equipment can be shut down or run on a separate small generator, consider leaving it off the main list. This keeps the generator size manageable and reduces fuel consumption during long outages.

Step 2: Account for Starting Surge

Many devices, especially electric motors, draw much more current when they start than when they run. This surge can last a second or two but can be three to seven times the running current. Motors in pumps, compressors, conveyors, and air conditioners are common culprits. If your generator cannot supply that starting current, the motor may not start, or the generator may stall or trip its breaker.



To handle starting surge, you need to know the locked-rotor amperage for each motor-driven device. That figure is often on the motor nameplate. If not, use a multiplier of 1.5 to 2 times the running watts for small motors and up to 3 times for larger ones. Then decide which motors will start at the same time. You do not need to size for every motor starting simultaneously if you can stagger their starts. In many installations, a transfer switch or a manual start sequence can prevent simultaneous starting surges. Add the largest single starting surge to the running watts of everything else that will be on at that moment. That total is your minimum surge capacity.

Step 3: Consider Fuel Consumption and Runtime

A diesel generator's fuel consumption curve is not flat. It burns a certain amount of fuel per hour at each load level. Most diesel generators are most efficient when loaded between 60% and 80% of their rated output. Running a generator consistently below 30% load can cause wet stacking, a condition where unburned fuel and carbon build up in the exhaust system, leading to reduced performance and higher maintenance costs. On the other hand, running at full rated output for extended periods shortens engine life and increases the risk of overheating.

When you size the generator, aim for a continuous load that falls inside that efficient band. If your essential equipment draws 20 kilowatts of running load, a generator rated for 30 to 35 kilowatts will typically keep you in the sweet spot. You also need to factor in the fuel tank size and refueling intervals. If you plan for long runtimes, a larger fuel tank or a connection to a bulk diesel supply will be necessary. Fuel consumption data from the manufacturer can help you estimate how many hours of operation a given tank will provide.

Step 4: Evaluate Voltage and Phase Requirements

Check whether your essential equipment runs on single-phase or three-phase power. Most residential and light commercial loads are single-phase, while larger motors, pumps, and industrial machinery often need three-phase. A three-phase generator can power three-phase equipment directly, but if you also have single-phase loads, you may need a distribution panel that balances the load across phases. Similarly, verify the voltage: 120/240 volts single-phase, 120/208 volts three-phase, or 277/480 volts three-phase are common. A generator that supplies the wrong voltage or phase will not run your equipment safely.

If your site has a mix of voltages, you might need a transformer or a generator with multiple voltage outputs. Some diesel generators come with a voltage selector switch or can be rewired to different configurations. This is also the time to plan for a transfer switch if the generator is for backup power. The transfer switch must match the generator's output and the building's service entrance.

Step 5: Factor in Environmental Conditions

Generator ratings are often given at standard conditions, such as sea level and 25 degrees Celsius. At higher altitudes or extreme temperatures, engine performance drops. For every 300 meters above 1,000 meters, expect about a 3% to 5% reduction in power output. High ambient temperatures also reduce the cooling capacity of the radiator and alternator, so a generator that works fine in a temperate climate may struggle in a desert or a hot factory. Derate the generator's capacity according to the manufacturer's guidelines for your specific site conditions. A generator that delivers 100% of its rated output at sea level might only provide 85% at 2,000 meters. If you ignore this, you could end up with a generator that cannot start your largest motor on a hot day.



Dust, humidity, and corrosive environments also affect generator longevity. In dusty conditions, air filters clog faster, and the alternator windings may need extra protection. In coastal areas, salt spray can cause corrosion. Enclosures and air intake treatments can help, but they add cost and may slightly restrict airflow, further affecting performance. A local dealer or an experienced generator installer can advise on the right enclosure and derating factors for your climate.

Step 6: Plan for Power Distribution and Load Management

Once you know the generator size, you need to get the power to your equipment safely. This means choosing the correct cable sizes, circuit breakers, and possibly a load bank for testing.

A load bank is a device that applies an artificial load to the generator, allowing you to test its performance without connecting actual equipment. It is especially useful for commissioning a new installation or for periodic load testing.

Install a power distribution panel that separates essential circuits from non-essential ones. Label every circuit clearly. If you have multiple large motors, consider adding soft starters or variable frequency drives to reduce starting surge. These devices ramp up the motor speed gradually, cutting the inrush current significantly. This can allow you to use a smaller generator than you would otherwise need, saving on initial cost and fuel.

Also think about how you will manage the load during an outage. If the generator is sized for all essential equipment running simultaneously, you have less to worry about. But if you have a tight budget or limited space, you can size the generator for the largest single load plus the running load of other equipment, and then manually start non-critical loads one at a time. A transfer switch with load-shedding capability can automate this process.

Step 7: Test the System Before Depending on It

After the generator is installed and connected, run a full load test. Turn on all essential equipment and let the generator run for at least an hour under load. Monitor voltage, frequency, and temperature. Listen for unusual sounds. Check that the automatic transfer switch works correctly when utility power fails and restores. If you have a load bank, use it to apply a load equal to the generator's rated output for a short period to verify the engine and alternator can handle full load without overheating or excessive voltage drop.

Testing also reveals whether the starting surge of your largest motor causes the generator voltage to sag too much. A voltage dip below 80% of nominal can damage motor windings or cause contactors to chatter. If that happens, you may need to adjust the generator's governor or install a larger unit. Better to catch this during testing than during an actual outage when critical systems are down.



A properly sized diesel generator that is installed and tested correctly provides reliable power for demanding sites. The process requires careful measurement, honest assessment of what is essential, and attention to environmental factors. The result is a power system that starts when needed, runs efficiently, and keeps your equipment operating through anything the grid or the site throws at it.

No single formula fits every situation. But by working through these steps, you can avoid the common pitfalls of undersizing or oversizing. The time spent upfront on sizing pays back in fewer service calls, lower fuel bills, and confidence that your essential equipment will keep running when everything else stops.