

Averting Common Causes of Generator Failure (Part 1)

Some tips to improve your understanding, and maintenance, of a standby power system.

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An automatic transfer switch (ATS) with door opened. Graphics courtesy of Peterson Power Systems.



Most people spend more time and energy going around problems than in trying to solve them. -Henry Ford

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More than ever, companies are dependent on a continuous supply of electric power. To safeguard their facilities from the disastrous consequences of power disruption, many companies are choosing to invest in standby power systems.¹ Standby generators and automatic transfer switches are two essential components of this continuous power solution.

"They ... [continuously] monitor the supply of electrical power ... [to the facility], and if there is a loss of power, the automatic transfer switch will start the standby generator and transfer ... [the facility load] to generator power."² This availability of continuous power helps a company maintain operation, avoid revenue loss and, ultimately, protect the bottom line: providing the advantage of reliability when competitors go down.

Investing in a standby power system is a costly expense. Therefore, it is only logical that a company understand how to properly use and take care of its power equipment to ensure clean, continuous power for business operations. A lack of generator maintenance or operation knowledge will, without a doubt, result in generator failure.

This article discusses what is necessary to ensure the reliability of your company's standby power system, by addressing two key issues:

1. The importance of possessing a comprehensive understanding of the power equipment being utilized; and,
2. The benefits of an established "baseline set of values that can be referenced during routine and ongoing maintenance."³

Know Your Power Equipment: A Review

Power equipment is built to be safe, reliable, and capable of handling heavy electrical loads upon demand. As power requirements increase and power equipment becomes more complex, the handling and upkeep of a standby power system must become a higher priority.⁴

"It is critical to confirm that the generator system control settings are properly set and functioning not only at the startup of the project, but remain set through the life of the project. These settings may need to be tweaked as the load profile of the building or the reliability of the serving utility changes."

A proper understanding of the operation and various components and settings of your generator system will ensure a quick and efficient

response to power disruption, planned or unexpected.

Automatic Transfer Switches (ATS). Automatic Transfer Switches allow a smooth, immediate, synchronized transfer of electrical current from a generator set to a facility's load. The ATS continuously monitors a business's power quality, and is able to automatically start the generator set to restore electricity to the load when utility power is interrupted. When utility power is restored, the ATS switches the load from the generator back to the utility system and automatically shuts itself down when the generator is completely disconnected and primary utility service is restored.

It is essential that you know the make (specifically, the manufacturer, model number, and style) of the automatic transfer switch you are using. This information may be located on the inside door or cabinet of the ATS, or in the owner's manual. Learn the purpose and location of the various devices (switches, lights, screens, and buttons). If needed, label these devices so that their purpose is clearly defined. In the event of a failure, this information will help you operate the ATS manually. Large power surges, like lightning strikes, can cause automatic transfer switch failure. If you have questions and/or concerns about manually starting the automatic transfer switch, contact qualified electrical companies and/or power suppliers for instruction. Their contact information should be taped inside the transfer switch for easy access.

Diesel Generators. Standby generators are an integral part of business continuity planning; but while companies invest hundreds of thousands of dollars in this type of equipment, often generators fail to properly start when needed. Generators are composed of various systems – cooling, fuel, battery and charging, engine, and generator controller – that must work together smoothly for the unit to operate properly.

The Cooling System. The cooling system contains a radiator, anti-freeze, a block heater, and a water pump. Some maintenance tips:

*Radiator fins must be inspected on a monthly basis and cleared of all dirt and debris. "Make sure the generator is OFF prior to inspecting by shining a light through the front of the radiator. If the light doesn't shine through the fins, carefully clear the blockage."⁵

*Antifreeze levels should be checked on a weekly basis.

*Make sure the block heater is plugged in and warm. Block heaters should be plugged in year round, as they reduce wear on the generator's engine.

*Inspect hoses and the water pump for signs of wear, bulges, cracking, and leaks; check the hose clamps for tightness. →

¹For more information, consult "Contingency Planning for Disrupted Electric Power: The Case for Partnering with a Strong Rental Power Supplier." Peterson Power Systems/CAT.
²Norman, Tim. "Generator and Transfer Switch Maintenance." The University of Delaware: Applied Poultry Engineering News Vol.2 No. 2, April 2004. ³<http://www.csemag.com/article/CA602440.html> ⁴<http://www.csemag.com/article/CA602440.html> ⁵Norman, Tim. "Generator and Transfer Switch Maintenance." The University of Delaware: Applied Poultry Engineering News Vol.2 No. 2, April 2004.

The Fuel System. The fuel system is made up of a fuel tank, filters, fuel lines and hoses, lines connecting the generator to the fuel tank, fittings, regulators, and fuel additives. The fuel filters in diesel engines should be changed at least once every year. Some maintenance tips:

*Know what type of fuel is required, the capacity of the fuel tank, and the estimate fuel consumption rate for the unit at 75% load and 100% load.
*Pay attention to whether wet spots appear around the fittings.

The Battery and Charging Systems. Some maintenance tips:

*Batteries must be functioning properly for the generator to be able to instantly start.
*The charging gauge (or indicator light) should read OK on the battery charger.

*Make sure the battery and charger connections are tight, and clean any corrosion off the terminals. The battery charger must be turned off before working on the battery or the starter.

The Engine. Some maintenance tips:

*Know the manufacturer of the generator engine and unit, the model number, and kW rating of the generator set. This information is required when calling for service on the unit.

*Inspect the engine for leaks and wear.

*Check engine belts for wear, cracking, splitting, or looseness.

*Check oil levels. The engine oil needs to be changed once every year.

*Inspect the air filter to make sure the filter canister does not contain dirt or other debris. The air filter needs to be changed once every year.

The Controller. The controller is a vital part of a generation system. The controller monitors all the engine and generator functions, such as the engine speed for hertz, oil pressure and water temperature. Some maintenance tips:

*It is important that you know how to start the generator manually.

*Knowing where the gauges, dials, and buttons are located on the controller, and how they function, will ensure quick and productive action in the event of an emergency.

*Knowing the size, type, and voltage of the fuses will allow you to



Automatic transfer switch (ATS) control panel inside the front door.

purchase extras to have on hand for protection against downtime due to dead fuses.

With today's complex standby power systems, it is important that you understand the basic settings of your system, the method and procedures involved in proper regular maintenance, and the protocol to deal with alarm conditions in the case of system failure. This information will keep you from wasting valuable business time over generator failure due to inaccurate settings or neglected maintenance. This point will be further emphasized in the following discussion of common reasons for generator start-failure, and what can be done to avoid these "no start" situations.

Common Reasons For Generator Start-Failure

1. Battery Failure. The single most frequent service call for generator failure is battery failure. Eighty percent of all battery failure is related to sulfation build-up: the accumulation of lead sulfates on the plates of lead-acid batteries. "This build-up occurs when the sulfur molecules in the electrolyte (battery acid) become so deeply discharged that they begin to coat the battery's lead plates."⁶ When enough plate area has sulfated, the battery will not be able to provide enough current and will normally need to be replaced.⁷

There are numerous reasons for sulfation build-up:

■ Battery failure is commonly the result of low electrolyte levels; battery plates exposed to air will immediately sulfate.⁸

■ Batteries that are always on a charge use water. Today's newer maintenance-free batteries allow water to condensate and refill their cells. As soon as the plates are exposed, the battery is junk.

■ Battery cells are shorted when sedimentary trays fill up with lead debris. Shorted batteries can be avoided if batteries are replaced every three years. Batteries more than three years old are very likely to fail or become weak.

■ Battery failure will result from open cells. However, this is not a common occurrence. Open cells are the result of an over current of the battery system. When a generator has had several battery failures determined to be caused by open cells, the unit may require larger batteries capable of higher CCAs.

■ Frequently, battery failure is due to the charger breaker being open or tripped. This is most often the result of human error rather than actual charger failure. It usually occurs after service on a generator, or some type of maintenance, where the charger has been turned off and not turned back on again when the service is completed.

The unit's various alarms should catch this error before an attempt is even made to start the generator. To name a few indicators: Charge Fail, AC Fail, Low Battery, and a General Failure Alarm. This type of failure is an excellent example of why it is important to remember

⁶http://www.batterystuff.com/tutorial_battery.html ⁷http://www.ibsa.com/www/faqs/tech_talk/terms/s.htm ⁸http://www.batterystuff.com/tutorial_battery.html

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that no matter who services your generator, humans make mistakes. Always double check a generator system after any service or maintenance to make sure that everything is in proper functioning order.

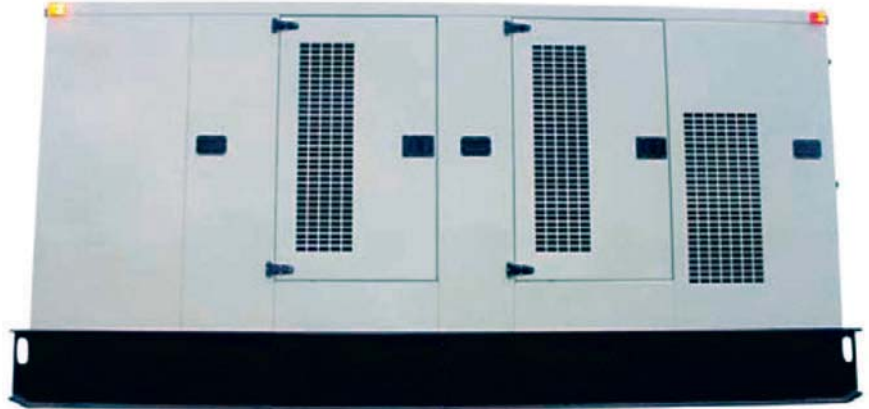
Battery maintenance is an important issue. Many battery problems are caused by dirty and loose connections. Cable connections need to be cleaned and tightened. Battery charger failures are difficult to prevent and cannot be accurately predicted. However, monitoring the charge rates from month to month will establish a trend that can help map the potential for failure. A properly functioning battery charger will have a constant charge rate for any given system. An increase of amperage may show signs of a battery or charger malfunction. Any sudden change in the charge rate for no apparent reason is cause for further investigation of the charging system.

2. Low Coolant Level Alarms/Shutdown. The most obvious cause for a low coolant level is either an external or internal leak. Close attention should be paid to notice any visible puddles of coolant during weekly inspections of the unit(s). The color of the coolant varies by manufacturers and may look like red-dyed diesel fuel. Oil should also be inspected for any signs of a change in color or a milky texture. Hoses should be inspected for "crusties" – the sign of coolant seeping and the additives drying up at the connection.

While many generators are equipped with this alarm, few generators have a dedicated alarm indicator for low coolant. Commonly, this alarm will be tied into a high coolant temp shutdown. If the generator is equipped with an "Approaching High Coolant Temp Alarm" or "High Coolant Temp Pre Alarm," you can determine which fault caused the shutdown. If the high temp shutdown is activated without a pre alarm, it is most likely responding to the coolant level.⁹

Internally plugged radiator cores will also cause low-coolant-level shutdowns. When the generator is under load, the thermostats open completely and the radiator cannot allow the proper amount of flow through the core. The coolant has to go somewhere, and so purges through the overflow line. As the engine cools off and the thermostat closes, the level drops and activates the low-coolant-level shutdown. This also occurs when float-switch-type coolant level sensors are used and the lines are plumbed to the top and bottom radiator tanks. When the thermostats open, the path of least resistance is through the float switch lines, and the flow causes the float to drop and shut down the engine. The thermostat will not open enough to cause this during regular weekly running of the generator. The generator will have to be tested under load to cause the thermostats to open completely. A full load test with an external load bank is the only accurate way to check a cooling system.

3. Low Coolant Temp Alarms. A genera-



The controller is a vital part of a diesel generator.

tor may need to be started up and allowed to run for a few minutes at no load so that the temperature comes up. This is not normally necessary, but will calm uncertainty over whether the generator will start cold or not.¹⁰ Low Coolant Temp Alarms are mainly the result of faulty block heaters. These heaters run 24 hours a day, 7 days a week, and periodically, they are going to fail. A block heater, however, will never cause the engine not to run.

Why have block heaters? A common misconception is that the engine does not need a block heater in California. A block heater does more than help the engine to start in cold weather. Due to the dissimilar metals that the engines are built with, accelerated wear can occur during start up. The pistons, normally made of aluminum, will expand at a faster rate than the iron cylinder liners. This rapid expansion of the pistons can lead to scuffing of the piston skirt. Block heaters relieve most of this scuffing by maintaining the cooling system temperature and keeping the cylinder liners expanded.

The extreme temperature inside the block heater is what causes the coolant to circulate through the system. (At times you can hear the coolant boiling inside the block heater.) The block heater's high temperatures flash off the coolant into small amounts of steam, causing the coolant to evaporate in slight amounts. While it takes a long time to show a difference in the coolant level, recording the amount of coolant added to the system will help establish a trend. (The block heater thermostat is located at the cold side of the heater.) If the engine is continuously using coolant with no signs of leakage, oil samples should be taken and analyzed, and further troubleshooting should be done. If the block heater temperature gets excessively high, premature block heater failure or extreme engine damage may occur. Some generators use a control panel to operate their block heater, particularly Onan's Power Command panel.¹¹

Normal walk-through inspections should include checking the cylinder head (or engine

thermostat housing) for temperature and verifying that the engine or block heater hoses are warm. The temperature setting should be between 90°F and 100°F, and never more than 120°F. The temperature gauge may read a different value than the thermostat setting.

Part 2 of this article will appear next issue and cover several more reasons for generator start-failure, as well as why it's important to stick to a preventative maintenance plan. FEJ

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⁹It must be noted that there are reported service calls where the pre alarm sensor was faulty and did not trigger the alarm. ¹⁰Pre-combustion chamber engines may have a problem starting; however, there are very few pre-combustion chamber engines still around. Some lean burn natural gas or propane engines may have starting difficulties when the weather is cold if they are not equipped with a choke. ¹¹You may notice that block heater hoses are cold in these systems. This is normal and is not necessarily a problem with the block heater.