

RURAL

Safety and Health

Safe Operation of Emergency Generators

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The continuous availability of electric power for our homes and farms is often taken for granted. To most individuals and businesses, a continuous supply of electrical power is not a luxury but is considered to be essential. On farms, the loss of power, even for a few hours, disrupts mechanical ventilation systems, livestock feeding and watering equipment, processing equipment and other electrical devices that are essential to the successful operation of the business. In rural homes, an extended power outage causes losses of refrigerated foods, causes loss of water supply, the loss of central heating systems and often causes the loss of cooking and water heating capabilities. Most farm operators and many rural homeowners consider an emergency generator to be necessary insurance against the effects of power outages.

Emergency Generator Selection

Emergency generators are driven either by a tractor PTO or by their own self contained gasoline, diesel or LP fueled engine. Tractor PTO generators are set up and operated manually during an electric power outage. Engine driven generators can be manually operated or set up to automatically start and operate when an outage occurs. Automatic emergency generator systems are much more expensive and manual systems because of the automatic transfer switching and required safety devices. Such systems are usually specified when there are critical power needs such as poultry house ventilation or human life support systems.



Large Permanent Installation

Generators are rated by the amount of power they produce, expressed in watts or kilowatts (1000 watts). A small portable generator might be rated at 6000 watts or 6 kilowatts. Be aware that manufacturers' ratings differ. Some manufacturers rate their generators based on the maximum short duration power they can produce for starting motors (e.g., 35,000 watts motor starting power). Such a generator cannot sustain a 35,000 watt output, and may only be able to maintain a 20,000 watt output continuously. Other manufacturers will rate their generators as 35,000 watts continuous with 45,000 watts motor starting capacity. Be sure you understand the rating of the generator you buy.

Selecting an emergency generator for household needs requires a decision about what electric circuits are really necessary during a prolonged outage. If you are only concerned about pumping water, running the furnace, operating a refrigerator and a few lights, a 4,000 to 6,000 watt portable, pull

start generator would be adequate. However, if you wish to maintain relatively normal living conditions during an outage, most household generators are not built to withstand the rigors of continuous operation for days on end. In the event of a prolonged outage (more than 8 hours), it is wise to shut down the generator two or three times per day to check fluids and allow the generator and engine to cool.

Farm emergency generators need to be sized carefully to meet peak load requirements during extended outages. While it is not usually practical to size the generator to meet all normally scheduled farm loads, it is often necessary to operate several major loads simultaneously (e.g., milking equipment, ventilation, water pump, lighting, etc.). Thus, farm emergency generators often start at 25,000 watts (25 kW) for smaller farms up to 150,000 watts (150 kW) or more for very large farms. It is important to seek assistance from an emergency power systems expert to determine the proper size and type of generator for a farm application. When sizing a generator, it is important to calculate the extra power requirements for large motor starts. Electric motors draw three to five times as much electric current to start as they do to run. For most farms, a tractor PTO driven unit will provide excellent emergency power service at a reasonable cost. Farms that have

outage, you may need a 12,000 to 15,000 watt generator. Household emergency generators are available as very simple critical loads such as poultry house ventilation, may require an automatic unit that provides standby power without delay.

For extended generation (more than 8 hours) either PTO operated or engine driven generators will perform well as long as the power source (tractor or stationary engine) is well maintained and carefully observed while it is running. PTO operated generators are often selected for farm use because of their portability for use at remote locations such as supplying power to a welder while making machinery repairs in the field. Low cost generators are generally constructed with lighter materials and are more likely to fail during long term operation because of the damaging effects of heat buildup within the unit. Electricity generation is a demanding process for the generator and the power source that drives it. Inexpensive generators are often incapable of meeting these demands and will often have a short useful life. The old adage, "You get what you pay for" is especially true when purchasing a generator. Purchasing used or government surplus generators can also lead to disappointing performance or unexpected failures.

manual units or as quite sophisticated, fully self-contained automatic units. One key



***PTO Powered Farm Generator
Ready for Service***

The power source (whether a tractor or a stationary engine) must provide at least 2 shaft horsepower per kilowatt of generator capacity. For example, a generator that will provide 100 kilowatts (100,000 watts) of peak electrical power requires a minimum of 200 engine horsepower to operate it at peak load. Large electric motor starts, such as a vacuum pump or silo unloader will demand even more power from the driving engine.

Finally, no matter what generator you select, be sure that it delivers the same voltage and frequency that your power supplier provides to you. In most cases, that will be 120/240 volts, 60 cycle alternating current. Large farms may take utility service at higher voltages, such as 277/480 volts, 3 phase, 60 cycle.

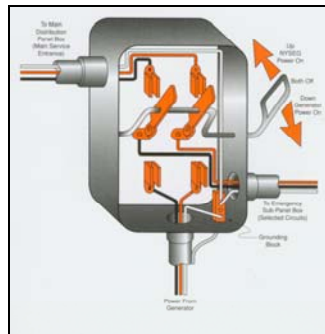
Transfer switches

All permanently installed generators must operate through a properly sized and wired transfer switch for safety. A transfer switch isolates the household or farm electric system from the electric utility system. There are several reasons for this requirement.

- If an emergency generator is connected directly to the house or farm electrical system without the isolation provided by a transfer switch, electric power can travel back through the utility service wires and onto the utility power lines. The 240 volts produced by the emergency generator will be boosted by the utility transformer to the distribution voltage level (e.g., 4800, 7200, or 12,000 volts or more). Unsuspecting linemen working on a supposedly dead power line can be killed or seriously injured.
- If the power produced by your generator is allowed to access the utility power line, your generator may energize a neighbor's electrical system and attempt to pick up any electrical load that may not be switched off. This could seriously overload and damage the emergency generator.
- Finally, without isolation from the utility power line, an operating emergency generator can be severely damaged or destroyed when the utility power comes back on. The utility power will be out of

phase (not synchronized) with the generator and will cause generator windings to be burned up.

There are two types of transfer switches: manual and automatic. Manual transfer switches are used with manually started emergency generators. Automatic transfer switches are used with engine driven generators that automatically start up when the utility power supply is lost. Transfer switches need to be sized for the current rating of each service connected to it. For example, a farm with a 400 ampere main service would require a 400 ampere transfer switch.



DPDT Transfer Switch

(Note: Diagram courtesy of NYSEG)



Pole Mounted Farm Transfer Switch

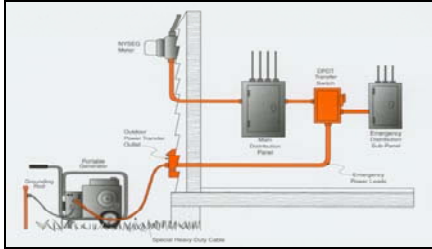
There are two considerations for transfer switches for household use. If only selected circuits will be energized by the emergency generator, then those circuits can be wired through a small transfer switch. If the entire house will be energized, then a transfer switch rated for the service size must be used. Your generator supplier can help you select and install the appropriate device to maintain proper operating safety.



Household Automatic Transfer Switch

Generator installation and maintenance

If you are using a small, portable generator to operate a specific piece of equipment, such as a table saw, the device can be plugged directly into the available outlet on the side of the generator. Such stand alone operation separate from any other electrical system requires no special installation considerations. Be sure to read the operator's manual to determine how to properly ground the unit before it is used.



Integrated System – Portable Generator Installation

(Note: Diagram courtesy of NYSEG)

All permanently installed generators need to comply with the National Electrical Code and local electric codes. If local electric code requirements for such installations exceed the National Electric Code requirements, the local code must be followed. It is important to have a qualified electrician provide the electrical installation for a generator. Often, the generator supplier is qualified to handle the entire installation. Don't attempt a do-it-yourself installation unless you are fully qualified and understand all requirements of the installation.

Permanently installed generators require plenty of open air space and good ventilation to carry away heat produced by the generator. Never install or run a generator in a tightly closed room. Excessive heat and carbon monoxide will create a very dangerous situation. Large, self-contained engine generators used on farms are often installed on a concrete pad located either outside or in a special shelter. If located inside, the engine exhaust is

plumbed to the outside and a wall fan is usually installed to provide extra ventilation.



Large Permanent Generator Located Outside

Permanent household generators are usually installed outdoors in a specially designed shelter that provides weather protection and adequate ventilation while the unit is operating. If a portable generator is used, it should be wheeled to a location near the house service entrance where a lead from the transfer switch can be attached to the generator output. The portable generator should be properly grounded, using the grounding tap provided on the generator control box. Never operate the portable generator in the basement or garage. The carbon monoxide produced by the engine is deadly.



Permanent Household Generator Installation

Tractor PTO driven generators are usually mounted on trailers

for easy movement to the point of use. The transfer switch on a farm is often located on the meter pole with a heavy power code used to connect the switch to the generator. The tractor and generator are parked and run at that location for the duration of the outage. An open, canopy structure can be placed over the generator to protect it from the weather while it is in use. Care must be taken to be sure the generator is stable and cannot tip. The tremendous force created within the generator as large loads are turned on can cause an unstable generator to flip over. The PTO shaft used for the generator should always be stored with the generator, and it must be properly shielded for safety so that the operator can't get entangled when it is spinning.



Properly Shielded Generator PTO Shaft

There are numerous maintenance issues to consider. Follow manufacturer's maintenance recommendations and schedules. A little time spent on preventive maintenance will assure that the generator will operate properly when you need it. Self contained engine

generators require numerous maintenance procedures. Engine oil and fluids must be checked regularly and change at recommended intervals. Batteries must be kept fully charged and battery terminals need to be kept clean and treated with anti-corrosion material. Fuel filters must be maintained and fuel should be fresh to facilitate quick starting and adequate power output. Keep the fuel tank filled. Often, engine generators don't start simply because no one checked and filled the fuel tank after the last use. Engine generators should be started and operated under load at least once per month for at least 30

minutes. A regular exercise period can be programmed for automatic generator systems. Always keep common spare parts near the generator to facilitate quick repairs. This should include filters, extra motor oil, spark plugs, and suitable starting aids.

It is important to use a well maintained tractor to run a PTO generator. Continuous operation of a generator with widely fluctuating loads is extremely tough duty for an engine. Look for oil or water leaks on the tractor engine and make sure all fluids are topped off at all times. Be sure the engine governor operates

effectively. Poorly responding governor will likely cause the engine to stall when a large electric load is turned on.

Keep a posted maintenance record which provides hours used, oil change and lubrication schedules, and other maintenance performed. Always follow manufacturers' maintenance recommendations.

When not in use, all portable and PTO operated generators should be stored in a clean, dry location. If dust and moisture collect on the generator windings, the unit may not generate electricity when you need it.

Generator safety

First and foremost, read and follow the safety instructions that come with the generator. It is wise to seal those instructions in plastic and keep them with the generator. There are many safety considerations that must be understood and followed to ensure safe, effective operation of your emergency generator.

- Don't use a generator indoors unless it's designed and installed properly for indoor operation.
- Make sure generator is properly sized to the loads you are energizing.
- Always provide plenty of ventilation for the generator.
- Be sure you have a properly sized and properly wired transfer switch. Make sure the transfer switch is in the auxiliary power position before operating the generator.
- Be sure all wiring is adequate and in good condition. Never use an undersized or frayed power cord to connect the generator to the transfer switch. If generator power cord becomes hot during use, replace it with larger size wire. Arrange and secure generator power cord to avoid tripping hazards.
- Make sure the generator is properly grounded.
- Keep all children away from the generator at all times. Generators become very hot during normal operation. Post warning signs about hot surface dangers.
- Do not remove or modify any safety devices on the generator or related equipment.
- Never overload the generator. Overloading can cause severe damage to the generator and to the engine or tractor used to drive it.
- Keep the generator dry to reduce danger of electrical shock and equipment failure.
- Always start a generator under no load. When it is up to proper operating speed and is producing electricity at the desired voltage and frequency, you can begin adding load. Start largest loads first whenever possible.

- Shut off all electric loads on the generator, and allow the generator to spin a few minutes before shutting it off.
- Never refuel the tractor or engine powering the generator while it is running. Shut the engine off and allow it to cool before adding fuel. Check all engine fluids each time you refuel. Check for fuel leaks often.
- Store fuel for the generator engine in a safe place, away from the generator.
- For PTO driven generators, be sure the PTO shaft is properly shielded. Never use a damaged or unshielded PTO shaft. Keep everyone away from the spinning shaft.
- Be sure the generator is well secured. Check all mounting bolts to see that they remain tight. Replace any broken mounts.
- Do not operate voltage sensitive equipment (computers, entertainment equipment) with a generator unless they are protected by a voltage surge protection device.
- If you have any doubts about the safety of your generator or the electrical wiring that connects it to your system, consult with the generator supplier and a qualified electrician before operating it.
- Make yourself fully aware of the sound your generating system makes under normal operation. If you hear unusual sounds, shut the generator down safely and inspect for problems.
- If operating continuously during a prolonged outage, shut the generator down at least once every 24 hours to allow it to cool and to inspect for equipment problems.
- **Adhere to manufacturer's operating recommendations.**

By following proper operating and installation procedures, performing regular maintenance and observing all safety rules, an emergency generator will perform effectively and safely for years to come.

For additional information:

- Cornell Agricultural Health & Safety Program. 1-877-257-9777, <http://www.diaglab.vet.cornell.edu/aghealth/>
- NYSEG Emergency Generator Safety



This publication is issued to further Cooperative Extension work mandated by acts of Congress of May 8 and June 30, 1914. It was produced with the cooperation of the U.S. Department of Agriculture; Cornell Cooperative Extension; the New York State College of Agriculture and Life Sciences, New York State College of Human Ecology, and New York State College of Veterinary Medicine, at Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities.

CU 2/06