CURTIS ENGINE

Generator

Sales • Service • Parts • Rentals

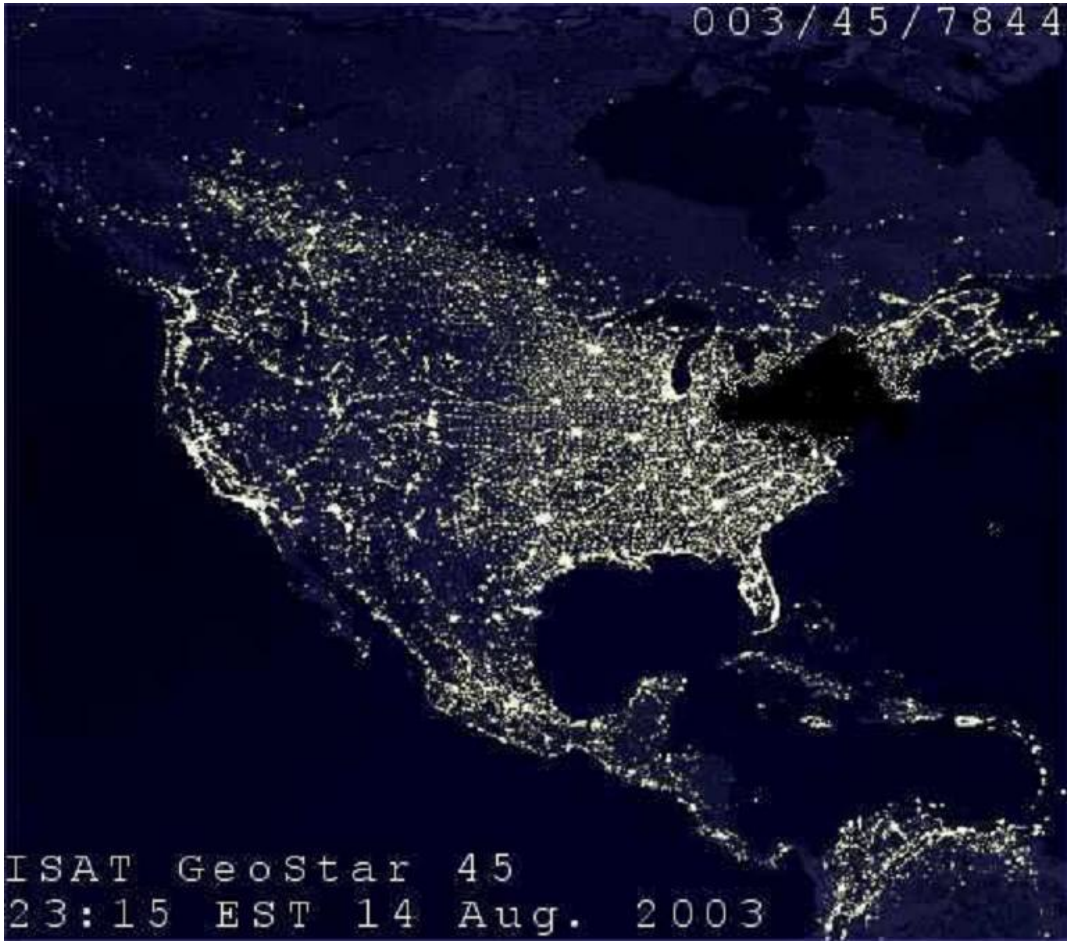
Emergency Power System Maintenance
Best Practices

The 2003 Northeast Blackout

During the 2003 Blackout in the Northeast, reports indicate that 20% of the generators failed to start or failed shortly after starting.

We recognize that you paid a great deal of money to protect your business or institution from power disruptions and that you expect the equipment to work flawlessly when called upon.

Curtis Engine offers a full-range of services designed to ensure that your generator and transfer switches will perform reliably when called upon.



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Why Do Generators Fail?

- Starting System issues are the #1 cause
  - Dead or weak batteries
  - Corroded cables or connections
  - Electrical or mechanical failure of the starter
- Fuel System issues
  - Old or contaminated fuel (water, bacteria or algae in the tank)
  - Fuel filter clogged
  - Fuel hoses or lines clogged or cracked
- Cooling System issues
  - Radiator clogged – internal or external
  - Hoses are deteriorated
  - Belts are cracked or do not have the proper tension
- Control System issues
  - Corrosion on electrical connections
  - Sensor failures
  - Circuit Board failures

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How Do You Avoid Genset Failures?

- Exercise the Generator weekly
  - Preferably under load for 30 minutes
  - This charges the battery, lubricates the engine, circulates and filters fuel and oil, burns off excess moisture, and keeps "critters" out.
- Follow a preventative maintenance and testing program
  - Perform weekly inspections looking for leaks, check oil and coolant levels, inspect belts and hoses, inspect battery terminals and cables.
  - Also, feel the block heater to ensure it is functional and ensure that the exhaust flap is closed.
  - Have a qualified technician perform a full inspection periodically.
  - It is important to keep written records of the inspections and tests
- Periodic load bank testing
  - Load bank testing confirms the generator's ability to reliably operate at its rated capacity for an extended period of time.
  - It also prevents and corrects "wet stacking" – a condition where unburned fuel deposits accumulate in the engine and exhaust system.
- Annual fuel cleaning and filtering
  - Stored diesel fuel begins to degrade within weeks of delivery and becomes contaminated with water and microbes which clog fuel lines and filters.

Typical Inspections Schedule for Gensets

Diesel Generator Set Maintenance Items	Method of Checking and Action to Take			
	Visual	Record	Action	Frequency
Battery System				
Electrolyte level	X	X	Check	Weekly
Charger and charge rate	X	X	Inspect	Weekly
Terminals clean and tight	X		Inspect/Check	Weekly
Leakages and spillage	X		Inspect/Clean	Weekly
Remove corrosion from case	X		Inspect/Clean	Monthly
Specific gravity or state of charge		X	Test	Monthly
Equalize charge	X	X	Check	Annually
Fuel System				
Main supply tank level		X	Check	Weekly
Day tank level		X	Inspect/Check	Weekly
Day tank float switch	X		Inspect/Test	Weekly
Supply or transfer pump operation	X		Inspect/Test	Weekly
Solenoid valve operation	X		Inspect/Test	Weekly
Strainer, filter and/or dirt leg	X		Inspect/Drain/Change	Weekly
Water in system		X	Check/Drain	Weekly
Flexible hose and connectors	X		Inspect	Weekly
Tank vents/overflow pipe blocked	X		Inspect/Replace	Annually
Piping	X		Inspect	Annually
Wiring in fuel system	X		Inspect	Annually
Fuel in main tank		X	Test/Filter/Biocide	Annually
Lubrication System				
Oil level	X	X	Inspect/Check	Weekly
Lube oil heater	X		Check	Weekly
Crankcase breather	X		Inspect/Clean/Replace	Semiannual
Oil change		X	Replace	Annually
Oil filter		X	Change	Annually

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Diesel Generator Set Maintenance Items	Method of Checking and Action to Take			
	Visual	Record	Action	Frequency
Cooling System				
Coolant level	X	X	Inspect/Check	Weekly
Adequate cooling water to heat exchanger	X		Check	Weekly
Adequate fresh air through radiator	X		Check	Weekly
Water pump	X		Inspect/Check	Weekly
Flexible water hoses and connections	X		Inspect	Weekly
Jacket water heater			Check	Weekly
Fan and alternator belts	X		Inspect/Check	Monthly
Antifreeze protection level		X	Test	Semiannual
Antifreeze PH test		X	Test/Replace	Annually
Rod out heat exchanger			Clean	Annually
Clean exterior of radiator			Clean	Annually
Inspect ductwork, clean louvers	X		Inspect/Check/Change	Annually
Louver motor and controls	X		Inspect/Clean/Test	Annually
Exhaust System				
Leakage	X		Inspect/Check	Weekly
Drain condensate trap	X		Check	Weekly
Insulation and fire hazards	X		Inspect	Monthly
Flexible exhaust section	X		Inspect	Semiannual
Excessive back pressure	X		Test	Annually
Exhaust system hanger and supports	X		Inspect	Annually

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Diesel Generator Set Maintenance Items	Method of Checking and Action to Take			
	Visual	Record	Action	Frequency
Engine				
General inspection	X	X	Inspect	Weekly
Service air cleaner	X		Inspect/Vacuum	Semiannual
Governor oil level and linkage	X		Inspect	Monthly
Governor oil	X		Change	Annually
Ignition system - plugs, cap, rotor, secondary wire insulation	X		Inspect/Check/Replace/ Clean/Test	Annually
Choke setting and carburetor adjustment	X		Check	Semiannual
Injector pump and injectors for flow rate, pressure, and/or spray pattern	X		Test	Annually
Load test		X	Test	Monthly
Valve clearance			Test	Every 3 years or 500 hours
Torque bolts			Test	Every 3 years or 500 hours
Generator End				
Brush length, apprearance free to move in holder	X		Inspect/Check/Clean	Semiannual
Commutator and slip rings	X		Inspect/Clean	Annually
Rotor and stator	X		Inspect/Clean	Annually
Bearings	X		Inspect/Replace	Annually
Bearing grease	X		Check/Replace	Annually
Exciter	X		Inspect/Check/Clean	Annually
Voltage regulator	X		Inspect/Check/Clean	Annually
Measure and record resistance readings of windings with insulation tester		X	Test	Annually

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Diesel Generator Set Maintenance Items	Method of Checking and Action to Take			
	Visual	Record	Action	Frequency
Electrical System				
General inspection	X		Inspect	Weekly
Circuit breakers, fuses	X		Inspect/Check/Clean	Monthly
Wire chafing if subject to movement	X		Inspect/Check	Monthly
Operation of safeties and alarms			Check/Test	Semiannual
Boxes, panels and cabinets			Clean	Semiannual
Tighten control and power wiring connections	X		Check	Annually
Calibration of voltage-sensing relays/devices			Check/Test	Annually
Wire insulation breakdown	X		Test	Every 5 years or 500 hours
Automatic Transfer Switch				
General inspection	X	X	Inspect	Weekly
Exercise the system under load		X	Test	Weekly
Automatic control system		X	Test	Monthly
Cabinet exterior	X		Inspect/Clean	Monthly
Tighten external components	X		Inspect/Check	Monthly
External operating mechanism	X		Inspect/Clean/Lubricate	Annually
Inspect interior of transfer switch	X		Inspect	Annually
Tighten internal components	X		Inspect/Check	Annually
LED indicators and remote control systems operation	X	X	Test	Annually
Transfer switch main contacts	X	X	Inspect/Clean/Replace	Annually
Tighten wiring connections			Check	Annually
Wire insulation deterioration	X		Inspect/Check/Replace	Annually

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Diesel Generator Set Maintenance Items	Method of Checking and Action to Take			
	Visual	Record	Action	Frequency
General Condition				
Unusual noises, vibrations, leakage, temperatures or deterioration	X	X	Inspect/Clean	Weekly
Service room/surrounding area	X		Inspect/Clean	Weekly
Restore system to automatic operation condition		X	Inspect	Weekly

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Load Testing

- Emergency generators should be tested at least monthly with available system loads.
- According to NFPA 110, diesel generator sets shall be tested monthly at not less than 30% of the rating.
  - If 30% of the rating cannot be achieved with the available system loads, a load bank test shall be performed annually at 25% of the nameplate rating for 30 minutes, followed by 50% load for 30 minutes, followed by 75% load for 60 minutes for a total of two hours of continuous operation.
- Healthcare facilities where life safety is a concern must also perform a four hour continuous load test every 36 months.
- Written records of all inspections and testing need to be maintained and available for inspection in the on-site maintenance log.
  - Include date, hour meter reading, and name of staff performing the inspection or test
- During a load test, record the start time, time to take over load, stop time, and total elapsed time
  - Also record gauge readings including engine temp, oil pressure, amps, and % of generator that is loaded at least every 15 minutes

Transfer Switch Testing

- Automatic transfer switches should be tested monthly.
  - The automatic control mechanism is switched from Auto to On and back to Auto position during the test.
- NFPA 110 requires an inspection, testing and maintenance program for transfer switches and paralleling switchgear.
  - An annual maintenance program including one major maintenance and three quarterly inspections is recommended.
  - The quarterly inspections include checking of connections, inspection or testing for evidence of overheating and excessive contact erosion, removal of dust and dirt, and the replacement of contacts when required.
  - The major maintenance includes a thermographic infrared temperature scan.
- Time delays should be set as follows:
  - On Start - 1 second minimum for diesel powered units
  - On Transfer to Emergency – no minimum
  - On Restoration to Normal – 5 minutes minimum
  - On Shutdown – 5 minutes minimum

Fuel Cleaning and Filtering

- Fuel should be cleaned and treated with biocides at least annually.
  - Bio-diesel should never be used in standby generators because it does not store well and becomes gummy and attracts moisture within weeks of delivery.
- According to NFPA 110 standards, the fuel system design for emergency and standby systems shall provide for a clean supply of fuel to the generator set.
  - A fuel quality test shall be performed at least annually
  - Additionally, fuel tanks shall be sized so that the fuel is consumed within the storage life, or a provision shall be made to replace stale fuel with clean fuel.
- Regular testing and exercise of the generator set helps get the fuel moving but fuel treatment and recirculation – diesel dialysis if you will – actually removes water and sediment from the tanks without replacing the expensive diesel fuel.
- Fuel that will be stored for a year or longer should be treated with additives to stabilize fuel and disperse contaminants.
  - Many older engines relied on sulfur to lubricate injection equipment. Due to today's ultra low sulfur diesel, additives should be added to ensure older engine fuel systems are adequately lubricated.

Other Tests Required by NFPA 110

- Circuit Breaker Testing
  - The main and the feeder circuit breakers between the generator set and the transfer switch loads are to be exercised annually with the generator in the Off position.
  - Additionally, the main and feeder breakers in excess of 600 volts are to be exercised every six months and are to be tested under simulated overload conditions every two years.
  - This requires careful planning and diligent coordination between management and maintenance staff to prevent a total power failure.
- Lead Acid Batteries
  - Lead acid batteries in the system shall be tested monthly for specific gravity and defective batteries shall be replaced immediately.
  - Specific gravity tests are performed with a hydrometer and should be 1265
  - Lead acid batteries are widely available and have a lower initial cost, but they have a lower cycle life than Nickel Cadmium, a lower temperature limit, and require more maintenance due to gassing.
  - Nickel Cadmium batteries is often chosen for standby generators because of its faster charge rate, longer life expectancy rate and fewer maintenance requirements.