# Load Bank Testing of Engine/Generator Sets

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Engine/generator sets, or gensets, represent a sizeable capital investment, and they are seldom installed as amenities of convenience. Their failure to perform properly when pressed into service is almost always accompanied by actual or potentially dangerous conditions and/or significant financial loss. Periodic maintenance and testing are essential to ensuring that the unit unfailingly performs its duties when called upon to do so.

Plant engineers with genset responsibilities are well aware of the need for preventive/predictive maintenance and periodic operational test-running of their units. If the genset is an emergency unit required by building safety code (as opposed to a standby unit installed at the owner's discretion), required minimum test conditions and frequency of testing are prescribed by applicable codes.

Periodic load bank testing is an important element of a comprehensive genset predictive maintenance program, but it is seldom specifically required by code. An example of one of the rare exceptions is found in NFPA 110 *Emergency and Standby Power Systems*, which requires load bank testing for mandated emergency units serving critical areas in hospitals.

A load bank is a stationary or mobile piece of equipment that provides operator-adjustable electrical resistance or resistance and reactance to simulate the actual electrical load the genset is intended to power. Load bank testing simulates the electrical demands of one or more items of electrical equipment, specific processes within the plant, or an entire facility. The test monitors the engine and generator to ensure that each is doing its job.

***This test should be an integral part of the engine/generator PM program***

### Effect of Power Factor on the Engine/Generator

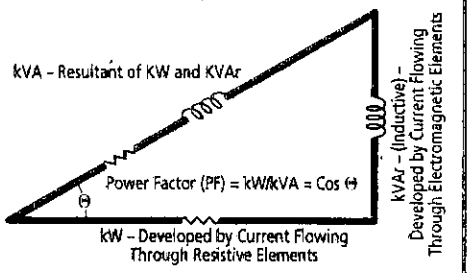
Industrial electrical loads comprise resistance and inductive reactance, with the latter induced by all electromagnetic devices. Inductive reactance causes current flow to lag the applied voltage by 90 electrical degrees. Solid-state electronic devices are nonlinear and their current waveform does not conform to the applied voltage waveform. They, too, cause current to lag the applied voltage in the manner of electromagnetic loads.

The vector resultant of resistance and reactance is the circuit impedance (see illustration). Current flow through the resistive component yields kilowatts (kW), and the kW level determines the horsepower load that will be imposed on the genset engine. Current flow through total impedance yields kilovolt-amperes (kVA), which translates directly into the heating that will be imposed on the generator.

The circuit parameter known as "power factor," or PF, is the ratio of kW to kVA. Power factor is usually expressed as a percent value. A PF of 0.80, for example, is typically expressed as 80%. Power factor decreases with increased reactance, and increases as the ratio of resistance to reactance increases. In a purely resistive circuit, kVA is equal to kW, and PF is 1, or 100%.

There are, in fact, few purely resistive loads in industrial plants; their existence is essentially limited to incandescent lighting and resistance heaters. Polyphase induction motors have power factors ranging from 50% to 90%, with the lower power factors applying to smaller and lower-speed motors. Power factor of welding machines ranges from 50% to 70%, arc furnaces from 80% to 90%, and induction furnaces from 60% to 70%.

**Components of Loading Imposed on Engine/Generator**




**Circuit resistance and reactance combine vectorially to form total circuit impedance. Current flow through the load resistive component yields kW, which, in turn, determines the horsepower load that will be imposed on the engine. Current flow through the total circuit impedance yields kVA, which translates into the heating that will be imposed on the generator.**

## Recommended Elements and Frequency of a Genset PM Program

The following recommendations for an overall engine/generator PM program are general guidelines only, to be modified in accordance with specific circumstances.

Weekly
The system should be started and operated for 30 to 40 min, either with or without electrical load imposed on the unit. A visual check should be made for fuel and oil leaks, and any abnormal noises investigated. Engine fluids, gauges, and instruments should be checked.

Monthly
The unit should be run for 30 to 40 min under actual load, and all weekly-check items observed. (Scheduled load bank testing increases in importance in cases where it is unfeasible to test gensets under load on a regular basis.) Engine cranking battery electrolyte levels should be checked, and battery specific gravity hydrometer readings should be taken.

Semiannually
Every six months or 250 engine-operating hr, a thorough inspection should be made of the entire cooling, fuel, starting, lubricating oil, and air intake/exhaust systems. Oil should especially undergo spectrophotometry and infrared analysis to confirm its integrity. System safety control systems and unit control panels should also be checked. The generator and exciter stator and rotor windings should be checked with a megohmeter to detect any insulation degradation.

Annually
Every year or 250 engine-operating hr, engine oil, and oil, air, and fuel filters should be changed. An engine coolant condition analysis should also be performed. The engine/generator should undergo a resistance/reactance load bank test over its full load range for a minimum of 2 hr.

Biannually
Every 2 yr, the engine coolant system should be thoroughly flushed and refilled. Upper and lower radiator hoses, belts, and block heater hoses should be replaced.

### Resistance-Only vs Resistance/Reactance Testing

Some genset test load banks contain resistance elements only, and therefore cannot provide a true simulation of the loading that the engine/generator will be subjected to in actual service. Many gensets are rated in kW at a specified power factor — for example, 1000 kW at 80% PF. Such ratings reflect the actual load conditions that the unit will be called upon to satisfy.

A resistance-only load test confirms the engine's ability to crank out a given kW, and the generator's ability to deliver an equivalent (equal) amount of kVA. It does *not* put the generator through the same paces it would experience under actual operating conditions. In effect, only engine performance is validated in a resistance-only test.

With a resistance/reactance load bank, inductance and resistance are selected to yield a value of impedance that collectively exposes the engine and generator to the loading that they will experience in service.

### Load Bank Test Verification of Voltage Regulator Operation

Only reactive load bank testing can verify the true performance of the genset voltage regulator; the regulator is not fully challenged in a resistance-only load bank test. The voltage regulator is what permits the system to recover quickly from large load changes.

When large block loads are applied, engine speed drops momentarily before recovering to its steady-state condition. The recovery interval is known as the "transient response." If the regulator is not functioning properly, recovery might not be possible. In some cases, the generator magnetic field might collapse, rendering the generator useless.

Testing with a resistance/inductance load bank permits block loads to be introduced having the same impedance characteristics as actual in-service loads.

### Problems Eliminated by Periodic Load Bank Testing

It is advisable to perform load bank testing on an annual basis, because it can eliminate problems brought on by neglect and underutilization. Weekly test operation under no-load or light-load conditions does not permit engine fluids to attain proper operating temperature. Cooling system controls will not be properly exercised, preventing coolant from circulating through radiators, and inviting failures stemming from inactivity. Engine safety shutdown systems are not subjected to actual operating conditions, and are therefore not fully tested.

Diesel-driven units are subject to a particular malady known as "wet stacking" or "slobbering" that stems from operation under no-load or light load conditions. Such operation causes fuel deposits to collect on the combustion chamber, injector nozzles, piston rings, turbocharger, and exhaust system. The result is diminished engine output capacity. Regular load bank testing burns off accumulated deposits and preserves engine output capability.

### Availability of Load Bank Testing Services

Load bank testing is available from the service organizations of engine/generator manufacturers, genset dealers, and some independent genset rental companies. When seeking these services, the supplier should be queried as to whether his test capabilities include resistance/reactance load bank testing, or resistance only. An ongoing maintenance service contract covering all PM activities should also be considered.

*— Edited by Ed Palko, Senior Editor, 708-390-2689*



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