White Paper

Load Banks for Hospitals and Healthcare Facilities

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Consistent and reliable power is a critical requirement for healthcare facilities. Power outages threaten patient safety and can put hospitals in non-compliance with industry standards. The maintenance and testing of integrated primary and secondary power supplies ensures reliability and reduces potential downtime. A load bank is the best practical means of ensuring power system reliability for mission critical environments such as a healthcare facility.

What is a Load Bank?

A load bank provides a consistent and repeatable electrical load that can be accurately controlled, measured, and recorded. Load banks convert or dissipate electrical energy into thermal heat energy. A basic load bank utilizes precise resistive elements cooled by an integral fan.

Load banks provide a stable and controllable load for evaluating power system performance. They can be as simple as a single resistor or as complicated as a resistive/reactive load system with computer control integrated into building management systems. They are primarily applied to generator sets; however, there are a number of other applications where they may be used.

Why are Load Banks Preferred for a Healthcare Facility?

In most cases, emergency power generating systems must comply with a number of different code requirements. In the United States, these include National Fire Protection Association (NFPA) 99 and 110 standards, Joint Commission requirements, Environmental Protection Agency (EPA) emission regulations, and National Electrical Code (NEC) specifications. Periodic load bank testing can help meet the Joint Commission, American Society for Healthcare Engineering (ASHE), NEC, and NFPA standards that address emergency power generation and testing in healthcare facilities. These codes are further described as follows:

The Joint Commission is a United States based nonprofit organization that accredits more than 21,000 US healthcare organizations and programs. Their standards for emergency power testing are summarized in Table 1.

TABLE 1: Emergency Power Testing Standards *(part 1 of 2)*

Standard	Description	Interval
EC 02.05.07 EP 4	Generators tested 12 x year (not<20 days or >40 days apart) for 30 continuous minutes under load.	Monthly
EC 02.05.07 EP 5	Generator test performed with 30% or greater of nameplate rating dynamic load or the exhaust gas temperature during test meets manufacturer's recommendations. If not, a test is performed every 12 months using a supplemental load bank as per EC 02.05.07 EP 5.	Annual if required
EC 02.05.07 EP 6	Transfer switches 12 x year (not <20 days or >40 days apart).	Monthly
EC 02.05.07 EP 7	Test generator for 4 continuous hours every 36 months.	36 Months

TABLE 1: Emergency Power Testing Standards *(part 2 of 2)*		
Standard	**Description**	**Interval**
EC 02.05.07 EP 8	36 month tests performed with a dynamic or static load of at least 30% of nameplate rating or the exhaust gas temperature during test meets manufacturer's recommendations.	See EC 02.05.07 EP 7
EC 02.05.07 EP 9	If a required emergency power system test failed, measures are implemented to protect patients, visitors and staff until repair or corrections are completed.	As applicable
EC 02.05.07 EP 10	If a required emergency power system test failed, a retest is performed after repairs are made.	As applicable

The National Fire Protection Association (NFPA) is a United States trade association, albeit with some international members, that creates and maintains private, copyrighted standards and codes for usage and adoption by local governments.

NFPA 99 - Healthcare Facilities Code - Healthcare facilities must exercise Emergency and Standby Power Systems under load and operating temperature conditions for at least 30 minutes at intervals of not more than 30 days.

NFPA 110 - Standard for Emergency Generator Systems - This standard sets safety standards to protect commercial building occupants by making sure generator-powered backup lighting will operate as expected. Monthly testing is performed on generators whose failure could result in injury or death. If a generator fails a monthly test, it should be tested annually for two continuous hours using a load bank. Under the continuous test, the generator should be operated at 25 percent of the nameplate kilowatt rating for 30 minutes, at 50 percent of the kilowatt rating for 30 minutes and at 75 percent of the kilowatt rating for 60 minutes.

The National Electrical Code (NEC) is a regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States. It is part of the National Fire Codes series published by the National Fire Protection Association (NFPA), a private trade association.

NEC Article 700 - Emergency Systems - Emergency systems are required to receive an operating permit as determined by the local code enforcement authority. This requirement is a lifeline for occupants, ensuring that lighting and life safety loads take priority over other building loads. Should the main electrical power supply fail, backup emergency power for life safety systems must be available within 10 seconds.

NEC Article 701 - Legally Required Standby Systems - Requires standby power to be available to legally required systems within 60 seconds of power loss. While NEC 700 is designed to ensure that people can exit a building, NEC 701 responds to the needs of firefighters and other personnel responding to an emergency.

NEC Article 702 - Optional Standby Systems - Applies to situations where standby generators are optional. In these cases, the systems may be put in place to protect against economic loss or business interruptions. For instance, data centers may elect to install backup power because an outage could result in large revenue losses.

NEC Article 708 - Critical Operations Power Systems - This article was developed following the 9/11 World Trade Center, Hurricane Katrina, and Hurricane Rita disasters in the United States. It requires a commissioning plan for on-site backup generation, baseline testing, and periodic witness testing, as well as a documented preventive maintenance program, written test records, and a method for testing all critical power systems for maximum anticipated load conditions.

Meeting ISO 8528 Standards

In international markets, ISO 8528 (BS7698) Part 6 is the standard for testing engine-driven generating sets. It details general test requirements and defines functional and acceptance load bank testing. Functional tests must always be performed, and usually occur at the manufacturer's test cell.

ISO 8528 (BS7698) Part 6 defines three performance classes - G1, G2, and G3. An additional class, G4, is reserved for performance criteria which are agreed upon between the supplier and the buyer. Each performance class has different criteria depending on the characteristics of the generator set:

- G1 is the least stringent and generally applies to small, simple generating sets intended to supply unsophisticated loads.
- G2 is broadly equivalent to commercially available power.
- G3 is intended for gen-sets that power strategically critical loads or those which particularly require a stable and accurate power supply.

TABLE 2: ISO 8528 Part 6 Performance Class Criteria

Performance Class	G1	G2	G3
Steady-State Frequency Band	2.5%	1.5%	0.5%
Maximum Frequency Dip	-15%	-10%	-7%
Maximum Frequency Rise	+18%	+12%	+10%
Frequency Recovery Time	10 sec	5 sec	3 sec
Steady-State Voltage Deviation	5%	2.5%	1%
Maximum Voltage Dip	-25%	-20%	-15%
Maximum Voltage Rise	+35%	+25%	+20%
Voltage Recovery Time	10 sec	6 sec	4 sec

In general, a healthcare facility is classified as mission critical and the need for reliable and consistent power is crucial. Therefore most facility gen-sets will be specified and manufactured to the most stringent 'G3' standards listed in Table 2.

Not only should the gen-sets meet G3 standards, but load test operators must ensure that G3 standards are met during annual and preventive maintenance testing. Advanced load bank control software can test to ISO 8528 G3 criteria automatically and produce a

detailed report with a pass or fail result and supporting data. The operator is provided with a clear indication on whether the gen-set is fit for purpose and is compliant with applicable standards. If gen-sets do not meet the G3 standards, a strategy can be established to evaluate and remedy the cause to ensure patient safety.

Why not use Building Load for Testing?

Conducting tests using building load may cause power interruptions when transferring from utility to generator, which are undesirable events for a mission critical healthcare facility. It also does not allow load to be applied in specific increments, so that performance can be monitored and recorded. Other disadvantages include:

- Depending on the time of day, building load may not exceed 30% load required to comply with Joint Commission requirements.
- Sufficient load may be unavailable for the duration required by the Joint Commission.
- Compliant UPS battery discharge testing may not be possible without a dedicated DC load bank.

For these reasons, load banks are the preferred method for load testing a generator system.

Preventive Maintenance of Power Systems

Diesel Engine Generator Sets are one of the main components in emergency backup power systems. Their failure to perform in a healthcare facility could result in catastrophic conditions. The main goal of load bank testing is to uncover potential gen-set problems in a controlled situation, rather than during an actual power failure. As a result, load bank testing is a critical part of gen-set maintenance program.

In the case of a standby diesel gen-set, a load bank test will indicate:

- The engine's ability to provide the required power output (kW).
- Voltage regulator response time.
- The alternator's capability to provide required voltage and frequency stability.
- The gen-set control system under varying conditions of load.
- Overall performance.

A load bank test will also help remove fuel deposits from pistons, engine castings, and exhaust (wet stacking). With data capture software, load test results can be recorded and analyzed to assess the condition of the backup power system.

Uninterruptible Power Supplies (UPS) systems deliver power during transitions between primary and back-up sources. UPS batteries must be routinely discharged to evaluate their condition and monitor any degradation over time. Matching a load bank to UPS capacity allows controllable testing and maintenance of the system, ensuring efficient operation.

What Type of Load Bank is Required?

Most gen-sets are rated in kW at a specified power factor (for example, 1000 kW at 0.8 PF). These ratings reflect the actual load conditions that the unit will be called upon to satisfy.

A resistive only load test will confirm the engine's ability to provide kW, and the generator's ability to deliver an equivalent kVA. However, a resistive only test will not "stress" the generator through actual operating conditions. In reality, only engine performance is validated.

With a resistive/Inductive load bank, inductive and resistive components yield a total impedance value that exposes the engine and generator to the loads that they experience in actual service. Testing at generator nameplate values requires a resistive/inductive load bank.

The ability to realistically simulate varying inductive loads is the primary benefit for a load bank that provides both kVA (resistive) and kVAR (inductive) loads. A combined resistive and inductive load bank allows testing of the alternator, load sharing, and transient response time.

Renting vs. Purchasing Load Banks

Since load banks are critical for power system testing, a decision must be made to either rent or purchase load banks. Each option offers benefits and the facility or site manager must analyze a multitude of variables. Gen-set rating, location, and usage must all be evaluated to make an informed decision.

2000 kW Resistive Load Bank installed at a healthcare facility. (Photo courtesy of ASCO Power Technologies)

Summary

It is critical for healthcare facilities to provide consistent and reliable power. When compared to building load, the use of load banks provides facility managers with stable, accurate, and reliable load test data. In addition, load bank testing assures that backup power systems will perform at 100% of their nameplate rating.

Without regular load bank testing, the risk of generator failure during an emergency increases dramatically. To avoid mechanical failure caused by the extreme stress placed on an engine and equipment during a power outage, load bank testing should be a regular part of a generator maintenance program. For healthcare facilities, a load bank allows comprehensive compliance testing and the simulation of sophisticated test scenarios without affecting ongoing operations.

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