

White Paper

Load Bank Utilization in Data Centers

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The data center industry is growing exponentially with construction of new facilities increasing every year. Power consumption is set to continue growing at an accelerated rate (see figure 1). Power reliability in data centers is crucial. A data center with 99% uptime per year will still have the equivalent of 88 hours of downtime. When you consider some larger data centers can lose thousands of dollars because of an outage, reliable power is vital. Load banks provide a means of testing and validating major electrical components in a modern data center to ensure efficient operation and reduce downtime.

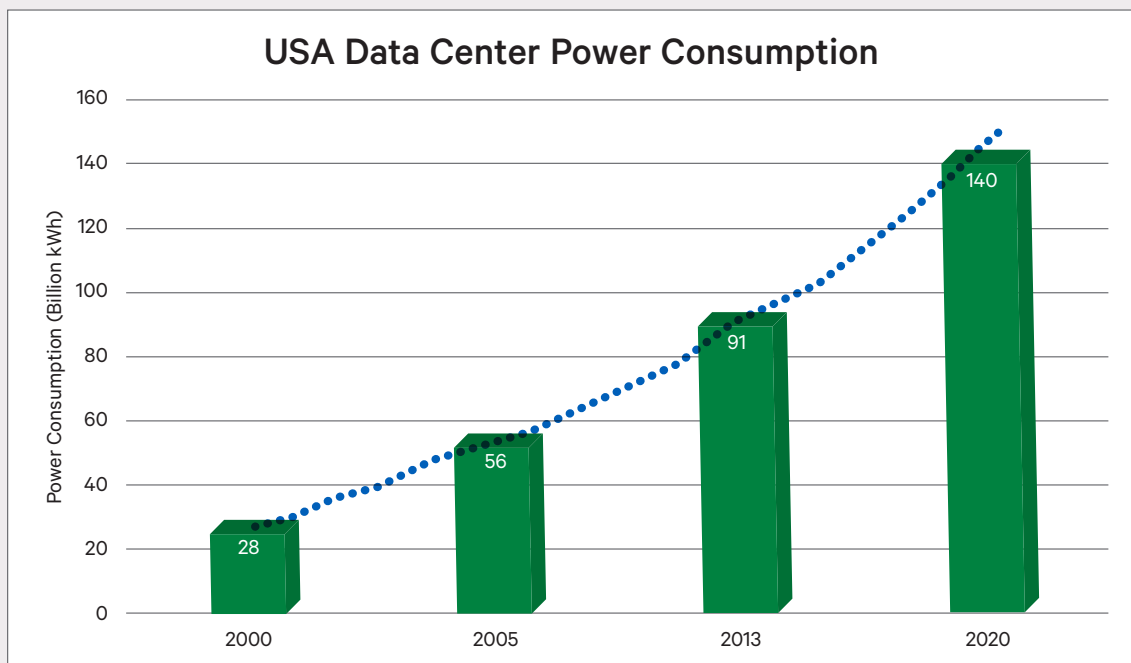


Figure 1: USA data center power consumption.
(source: www.quotecloud.com/how-to-choose-the-best-green-cloud-hosting-provider/)

When are Load Banks used in Data Centers?

There are typically four main applications where load banks will be utilized in data centers.

- Commissioning
- Expansion
- Maintenance/ Periodic Testing
- Component Replacements

Each application has varied requirements of power, size, type, and technical specification. Ensuring the correct load bank is used is vital in ensuring optimum testing.



Photo courtesy of ASCO Power Technologies

Commissioning

Commissioning is the process of assuring all systems and components of an industrial facility are tested, installed, and operated to the requirements of the end user. Commissioning will help identify potential issues and ensure components and systems are working safely and efficiently. Load testing in the commissioning phase will ensure any faulty electrical components or systems fail and are replaced accordingly before going 'live'. Real life load is not always available in the initial phases of construction as many data centers plan to expand as they go. Load banks are the only practical way of simulating real life load and will provide reassurance of the quality of components.

During the commissioning phase of a data center numerous critical components should be tested by load banks including back-up diesel generators, UPS systems, HVAC systems, bus tracks and tap offs, power distribution units, remote power panels, and server racks. A variety of types of load banks can and should be utilized to ensure testing is performed correctly.

Maintenance/Periodic Testing

The importance of back-up power supplies in data centers is critical. Numerous power and back-up power sources need to be rigorously maintained. Most data centers have a back-up UPS systems and diesel generators to supply power if the grid fails. Regular maintenance is vital in ensuring reduced down time in data centers, in the US an average cost of one minute of downtime is estimated at \$7900 USD¹. Load banks are the most effective way to test and stress electrical systems for maintenance and periodic testing purposes. A variety of load test types can be configured for specific maintenance purposes and reports will identify issues in systems that can be replaced or fixed to ensure efficient operation.

Expansion

Routinely, data centers are built larger than initially required with the aim to expand. As expansion occurs, correct simulation of power usage and cooling adaptation will be required. New components and hardware must prove operation and efficiency, especially in locations where sensitive or important information may be stored.

Load banks are the leading technology for simulating the real life power conditions of server racks. Most load banks will have the sophistication to provide detailed test reports. These reports can be used as proof of electrical compliance for clients who wish to purchase server space.

Component Replacements

Load testing is an effective process for testing and verifying all components in a circuit. Referring to the bathtub curve (see figure 2), failure starts to rise as components age and reach

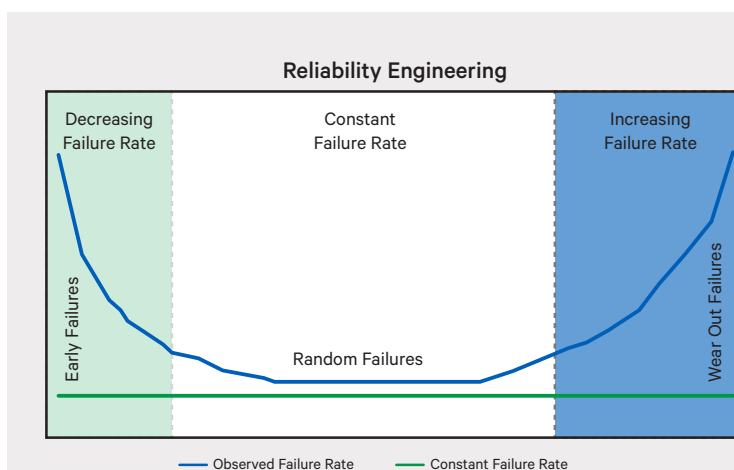


Figure 2: The bathtub curve, reliability engineering.

¹ Data Center Dynamics (<http://www.datacenterdynamics.com/content-tracks/power-cooling/one-minute-of-data-center-downtime-costs-us7900-on-average/83956.fullarticle>) found the average downtime for one minute in data centers in on average US \$7900. (4 December 2013)



Photo courtesy of ASCO Power Technologies

the end of their life cycle. The graph shows in early life there is an initial high failure rate, however this decreases as defective products are removed and installation errors are reduced. As the product gets older and wears out the failure rate begins to increase again, creating this bathtub curve. This directly correlates to data center electrical systems and components. Load banks can effectively test electrical systems, which reduces potential future downtime.

Where are load banks used in data centers?

Where Should Load Banks be Utilized?	Typical Load Banks
Back-up Diesel Generators	Resistive and Inductive Permanent Load Banks
Heating Ventilation Air Conditioning System	Resistive Portable Load Banks
Uninterruptible Power Systems	Resistive Permanent Load Banks
Server Racks	Server Rack Load Banks
Substation	HV Permanent Load Banks
Power Distribution Units	Resistive Portable Load Banks
Remote Power Panels	Resistive Portable Load Banks
Bus Tracks	Resistive Portable Load Banks

Back-up Diesel Generators

The majority of data centers have a diesel generator located on site to supply power in the event of an outage. Loss of power in data centers can cost people and businesses millions of dollars via lost sales, loss in customer confidence, and steep financial penalties for missing service level agreement contracts. Correct operation and maintenance of the diesel generator is vital in ensuring maximum uptime of a data center.

Load bank testing is the preferred method of ensuring efficient operation of a gen-set. A load bank will simulate electrical load and allow the operator to find potential issues and faults on the gen-set so in the event of a power outage it will work as required. A load test will ensure correct operation of the voltage regulator, governor, cooling system, fuel system, control system and also prevents the dangers of wet stacking that are typical on lightly loaded generators.

Wet Stacking occurs from operation under no-load or light-load conditions. Operation in an unloaded condition (such as extended idle time) or continual use at less than the recommended minimum load level causes fuel deposits to collect on the combustion chamber, injector nozzles, piston rings, turbocharger, and exhaust system. The result is diminished engine output capacity.

Either a purely resistive or a resistive inductive load bank can be used to test the diesel gen-sets. A purely resistive load bank will confirm an engine’s ability to provide kW and deliver an equivalent amount of kVA. A resistive inductive load bank will fully test the power supply as it will provide impedance supply currents out of phase with voltage.

Diesel generators should be load tested frequently. Typically, in larger data centers permanently installed containerized resistive inductive load banks are used to meet the higher capacity and endure tough outdoor conditions. Many load bank suppliers have control systems to

perform automatic and transient load tests. The load test results can be saved and filed to build a picture of the health of a generator over time. Alternatively, load bank control can be integrated into existing control systems typical in larger data centers.

Heating Ventilation Air Conditioning (HVAC) Systems

Overheating of server racks is an issue that could have catastrophic consequences. Load banks are now an integral part of heating, ventilation and air-conditioning (HVAC) commissioning. Load banks produce heat as a by-product of dissipating electrical power. The heat produced simulates that of a server rack and the more electrical power dissipated the more heat produced. The reaction to the heat produced can be monitored to test the effectiveness of the HVAC under load. Smaller load banks can be manoeuvred to specific parts of the data centers to test aspects of the HVAC system.

Load bank networking has revolutionized HVAC testing in data centers. Load banks can be connected in a network and strategically placed throughout a data center hall to simulate the actual server locations. All the load banks within the network can be controlled by a single handheld control to save operator time and ensure consistent load on all load banks. Furthermore, within a network the operator can configure individual load on single load banks to create hot spots.

Uninterruptible Power Supply (UPS) Systems

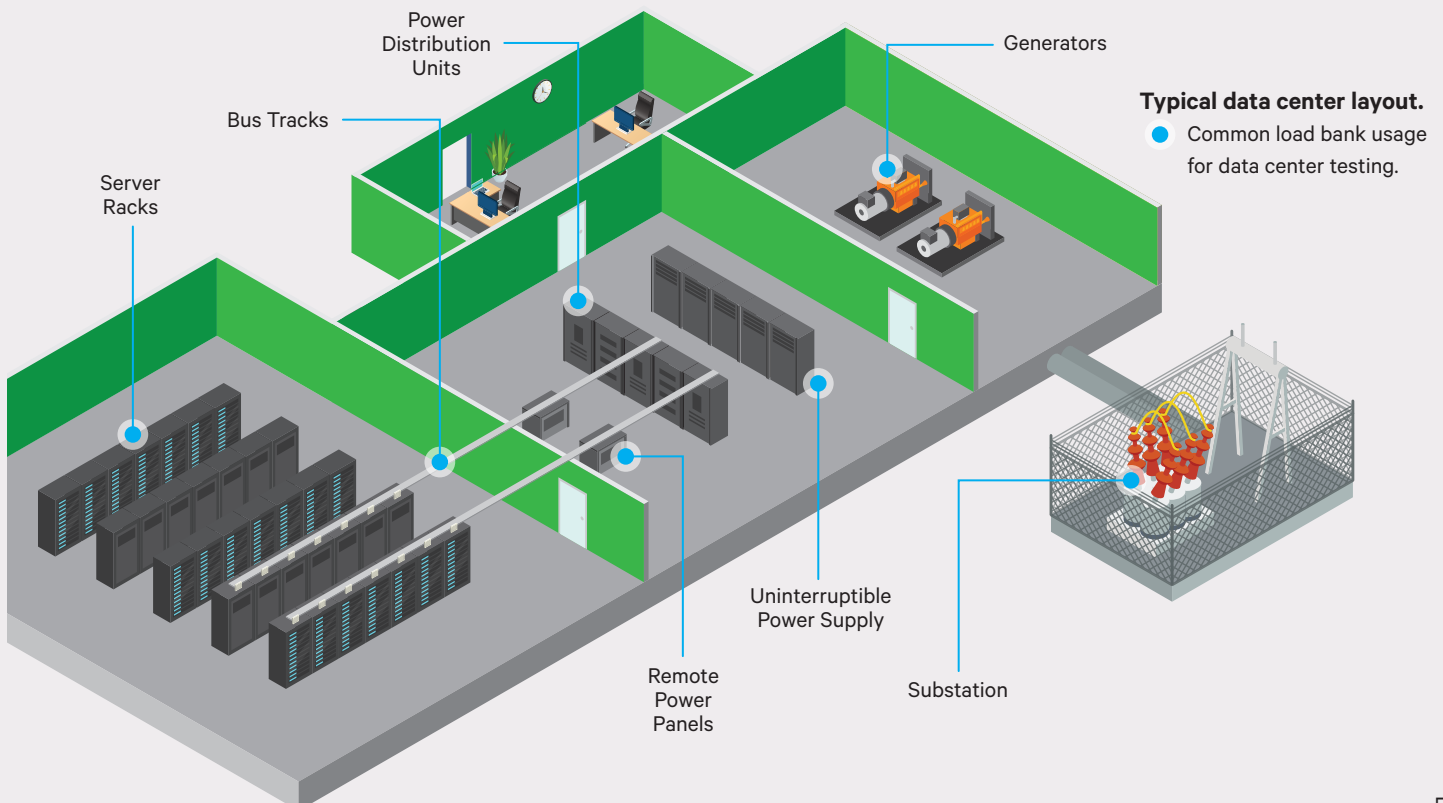
UPS systems are now standard in most data centers. In its simplest form, a UPS is a number of battery packs within an enclosure that automatically start if mains power fails. UPS systems bridge the gap between grid failure and the back-up power source starting. The UPS may only need to run for a few seconds or minutes, however seamless power source transition is vital.

Load banks validate correct operation and performance of a UPS system. The load banks discharge the batteries to keep in a healthy condition and determine autonomy. The invertors and distribution can be monitored as load is applied to ensure correct operation.

Typically, UPS systems will be tested as part of a scheduled maintenance program with other back-up power supplies such as diesel generators. Permanently installed resistive load banks are typically used in UPS testing.

Server Racks

Lower capacity load banks can be purpose built to fit into standard server racks. The rack mounted load banks simulate heat and power consumption that servers would create. This is a much more cost effective method of finding potential errors in power and operation than



risking using expensive servers to find potential faults. Once the server racks have been validated the real life server can be installed with the knowledge that the power will be reliable and it will not overheat.

As part of the data center commissioning process, room design, equipment placement, and the effectiveness of the room's cooling system all have to be tested and verified. The challenge is that room validation tests must be completed prior to the installation of servers and other equipment. Whole room temperature testing is notoriously inaccurate at recreating production conditions, increasing the likelihood of the need to reconfigure and re-test the cooling system and aisle layout after production servers are in operation. This can add significant costs to data center budgets and requires downtime of production systems to correct. Server rack mounted load banks are designed to reduce this risk.

With its ability to vary electrical load, discharge heat and airflow, the rack-mounted load banks precisely simulate the operational conditions of production servers, and validate the hot/cold aisle cooling design before the first server is installed. By validating the cooling system's ability to sustain the designed temperature delta of the production server configuration, data center managers can minimize the risk of having to re-work the cooling system or aisle configuration of a data center at a later date, which has many inherent pitfalls including downtime, cost, and disruption.

Substation

Load banks can test the gross capacity of substations and verify relays and metering. A load bank can also be used in conjunction with a transformer to test medium and high voltages. The power output by the substation must be reliable and able to meet data center power demands and a load bank is the best method to achieve this.

Power Distribution Units (PDU)

A power distribution unit is a device for controlling electrical power in a data center. Many are rack mountable and control/monitor the power to servers, switches, and other devices. Resistive load banks are often used in the commissioning phase of a data center to test the PDU's and ensure correct operation. The typical size of PDU is between 100-300kVA, therefore portable castor mounted load banks are often used for testing. The portable load banks can be positioned at each PDU in the data center hall, power can be applied and the PDU operation can be monitored. Load testing PDU's is a cost effective method of ensuring that multiple racks will be receiving the required power for operation.

Remote Power Panels (RPP)

Remote power panels are used in conjunction with PDU's. The RPP is a separate enclosure that allows a sub-feed from a PDU to connect a distribution panel distributing power to rack systems. The RPP allows the PDU to be located in a separate computer room and allows PDU's larger than 300kVA with large sub feed breakers to be utilized. Load banks are regularly used when commissioning RPP's to ensure efficient operation and distribution of power from the PDU to the rack systems.

Bus Tracks

Bus track power distribution is becoming more common in data centers allowing greater flexibility and accommodation of rising power densities. Load banks will test the bus tracks power units, feed tracks, and tap offs to ensure efficient operation.

Renting vs Purchasing Load Banks

During the commissioning phase, load banks are utilized for testing numerous electrical components (as discussed earlier in this document). The renting or purchasing of load banks will depend on the location, size, security, and maintenance schedule of the data center. Analysis of these variables will allow the site manager to make an informed decision.

Summary

The global power consumption of data centers is increasing year after year and the importance of reliability is mission critical. The resulting uptime is directly derived from correct commissioning and maintenance provided by load banks. Reducing downtime due to electrical system and component issues ensures there is no loss of data, loss of sales, or financial penalties.

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