DATA CENTER KNOWLEDGE

Using Load Bank Solutions to Optimize Data Center Commissioning

Accurate simulation of high-density server environments identifies configuration inefficiencies before production

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Overview:

This paper explores how data center operators who properly leverage load bank technology during data-center commissioning can validate electrical and mechanical infrastructure performance, isolate and correct issues before production, qualify for LEED certification, accelerate commissioning, and reduce overall data center commissioning costs.

Introduction:

Conducting load bank testing allows data center engineers and facility managers to minimize the likelihood of costly post-deployment configuration changes. Load bank testing validates room design, equipment placement and effectiveness of cooling-system and power-distribution infrastructure. Early identification of potential problems avoids delays and cost overruns during commissioning and operational downtime post-deployment. Furthermore, full system integration testing of critical systems during commissioning establishes an accurate baseline for ongoing operational performance and is a valuable sales and marketing tool in discussions with future tenants.

Load bank technology provides accuracy, efficiency and safety in commissioning

The demand for higher server density has substantially increased the complexity of data center design and implementation. High server thermal output, hot-aisle/cold-aislerack positioning and complex cooling mechanisms increase the difficulty of data-center simulation. Precise simulation of the operational characteristics of production servers requires technology that mimics the electrical load, heat generation, airflow, and physical dimensions of actual server racks. Traditional simple "suitcase" load banks are often not able to simulate airflow properly, resulting in the failure to predict hotspots in production deployments. A platform of rack-mounted load banks that can vary electrical load, heat and airflow and simulate "black start" and maximum operating conditions is essential to precise data-center simulation.

Leveraging the proper load-bank solution also ensures that the commissioning process itself occurs within budget. Labor is by far the largest single line item during the data center commissioning process. The ability to manage Wi-Fi-enabled load banks with Windows and Android devices eliminates the need to physically move around the data center to manually adjust load steps and fan speeds in order to complete tests. In addition, medium-voltage load banks reduce required cabling by a factor of fifteen and reduce setup time by a factor of five, further decreasing labor costs while creating fewer points of failure. Highly configurable load banks for raised floor testing containing vari-

able-speed fans and virtually infinitely configurable load-step resolutions per channel allows for more granular tests in less time. Furthermore, new power-quality monitors have improved capabilities to collect a data set more rich than what could be achieved just a few years ago - measurements can be taken at the rack, aisle or room level from indefinite collection points.

In addition to accuracy and efficiency, load-bank solutions must not jeopardize the safety of the electrical and cooling systems they test. To avoid disaster during commissioning, it is essential to leverage systems that provide wrong-voltage detection, power-supply shutdown, and thermal overload protection.

State-of-the-art load bank testing systems for all types of infrastructure

During data center commissioning, the performance of the following types of supporting infrastructure must be validated: Back-up generators, UPS systems, automatic transfer switches, Power Distribution Units (PDUs), Computer Room Air Conditioning (CRAC) systems and server containers and layouts. Generally, the more advanced the load bank technology, the more accurate the testing results, and the more money that can be saved in labor during the commissioning process. It is worthwhile to become familiar with the latest developments in testing equipment for all types of data center infrastructure.

For data centers deploying medium-voltage generators (a relatively common occurrence today), commissioning labor costs can be reduced through the use of transportable medium-voltage (13.8kv) load banks that do not require separate transformers. Systems are commonly available that dissipate five megawatts and are linkable for loads up to 100 megawatts. Set up requires a smaller number of medium-voltage cables (as few as one per phase) – drastically reducing set-up time. In addition, similar load banks can be used to test the behavior of UPS systems during a simulated power outage. Linkable load banks for UPS testing (often in the 400 kW range) are available that can be used to test resistive and reactive loads at a variety of power factors (PFs).

Not only must power generation be tested, but also power distribution. New Systems are available that accommodate power distribution unit testing in a variety of locations, including under the raised floor track, in a remote power panel or in an overhead bus track. New bus track adapters allow for faster set up and shorter cable runs. Similarly, advances in power monitor technology offer analogous flexibility and optimization. The most modern power monitors provide mechanisms for simple linkage to

a variety of real-time reporting systems and often contain a number of advanced features like current summation and temperature/humidity readings.

The testing of cooling systems is just as critical as that of power systems. It is essential to ensure the CRAC's capacity to provide optimal thermal conditions (constant temperatures and humidity levels) at high server loads. Testing systems must be used that measure room air flow (in cubic-feet per minute) and room temperature change ("delta T") in a variety of room configurations and container environments. For the commissioning of the chiller and chilled-water loop, a water-cooled load bank is essential. Ideally, the water-cooled load bank would be network-controllable and have variable flow and thermal-load controls. Such systems allow for precise simulation of the actual production water-cooled server environment. Light weight systems with built-in casters and small, tankless heat exchangers require low amounts of water and therefore reduce the risk of leaks and extreme flooding.

Purchasing vs. Renting

Although load bank systems can be purchased, it is often more cost effective to rent the systems instead, as the systems are typically used only once (during commissioning). In addition to the significant initial capital expenditure, load banks must be serviced, maintained and stored. There is also the added cost of logistics management and personal property inventory taxes. When added up, the total cost of ownership is significantly higher than is expected. Furthermore, rented load systems have a higher on-site reliability factor; power monitoring tools are calibrated before each rental and often have upgraded firmware/software, ensuring better accuracy and lower overall cost.

Long-term benefits of structured room validation testing

Although load bank, cable and switch gear rental is not inexpensive, these costs are eclipsed by the capital saved through the avoidance of expensive problems post-deployment. Identifying problems during the commissioning phase provides the opportunity to fix issues before a facility goes into operation. Even if an enterprise reduces by just a few percentage points its total IT labor costs over the life span of a typical data-center, then load bank testing will provide positive return on investment. It is always less expensive to fix a problem before data-center operations begin than after servers are put into production. Peace of mind is valuable to the client.

Beyond the obvious advantage of ensuring operational success of a newly constructed data center via validation of system design and performance, load bank testing is critical to success in other areas, including:

- **Documenting thermal and electrical load requirements**
  - Reassures clients of protection against uninterrupted service by confirming that equipment meets all test specifications (e.g., validation of backup-generator and UPS performance)
  - Reduces technical and financial risk of future data center upgrades or expansions
- **Ensuring accuracy of budgetary data**
  - Validates capital expenditure (CAPEX) budget by confirming that equipment meets all test specifications
  - Confirms power and cooling requirements for incorporation into operating expense (OPEX) budget
  - Reduces financial risk to clients – reducing the likelihood of unbudgeted cost increases
- **Simplifying compliance with regulatory requirements**
  - Provides integrated commissioning plan to fulfill requirements of contact award/negotiation process
  - Ensures compliance with local, state and federal environmental regulations – vital to construction permits
- **Leadership in Energy and Environmental Design (LEED) certification**
  - Assists clients in attaining LEED certification
  - Demonstrates commitment to environmental stewardship – generating favorable publicity
  - Meets customer requirements - often a prerequisite for contract award
  - Ensuring coordination and communication among commissioning a gents and general, electrical and mechanical contractors

Developing a structured commissioning plan that considers the effect of load bank technology

Regardless of the type of load bank testing systems incorporated into a data center's commissioning process, it is essential to develop a granular, comprehensive testing blueprint that anticipates future computational demands on the server infrastructure. Furthermore, load bank test planning should occur as early in the overall project timeline as possible, because load bank testing promotes an iterative design model: Test specifications that are not validated initially can be referred back to engineers for redesign and optimization. This proactive, structured approach identifies problems before the facility becomes operational, ensuring that the IT infrastructure is able to perform at capacity upon deployment.

An integrated commissioning plan supports a thorough risk assessment that focuses on:

- Verifying system power-consumption and thermal performance prior to production using a simulated operating environment
- Identifying path toward LEED certification
- Collection of data to support future expansions/upgrades
- Reducing financial and technical risks of re-engineering

Case studies: Reactive vs. proactive approach to data center commissioning

Note: In the following comparative analysis of approaches to load bank testing, the names of two actual companies performing data center construction are changed to "Enterprise A" and "Enterprise B".

Enterprise A waited until its data center construction project was near completion to finalize the load bank testing plan. Engineers failed to adequately plan for total load requirements, equipment placement (specifically ingress and egress) and cables runs. When the equipment arrived, the load banks did not fit in the freight elevator and had to be relocated outside. As a result, the cable runs were short and the schedule was delayed. It rained on the day the test was scheduled to begin and as indoor load banks don't function well in the rain, the schedule was delayed again. It was also assumed that unforeseen deficiencies could be addressed as IT equipment was actually being deployed, so the test did not fully validate hot-aisle/cold-aisle layout and CRAC performance. As a result, there were numerous costly data center configuration changes and delays in raised floor delivery. To recover, a comprehensive and expensive initiative involving electrical and mechanical contractors was required to rectify numerous electrical and mechanical

performance issues. In the end, the lack of coordination between the design firm, general contractor, electrical contractor, mechanical contractor and commissioning agent resulted in a project that was over budget and delivered behind schedule.

Enterprise B started developing the commissioning plan almost a year before commissioning was scheduled to start. With the involvement of the developer, the General Contractor worked with the Electrical Contractor, the mechanical contractor, the commissioning agent as well as the load bank supplier to develop an integrated commissioning plan. As the specifications were reviewed, it was determined that there was a requirement for a level of hot aisle/cold aisle testing granularity for which there was no available solution. What was needed was a rack mounted server simulator that simply did not exist. There were also integrated systems tests involving the generator plant and UPS that required multiple load bank solutions and test coordination. However, because the commissioning plan was discussed and developed very early in the

Summary of Case Studies

APPROACH	ENTERPRISE A – REACTIVE	ENTERPRISE B - PROACTIVE
Planning	The commissioning plan finalized late in construction process and load banks procured at the last minute	Commissioning plan coordinated with GC, EC, MC, Cx and load bank vendor months before start of commissioning.
Commissioning	Rule by Murphy. Significant problems resulting in schedule delays and cost over runs. Multiple independent systems tests.	Integrated systems commissioning plan with simulation of thermal & electrical loads to validate design specs & operational performance.
Schedule	Numerous technical issues identified post-delivery, requiring expensive retrofits. Delivery delayed.	Highly reliable data center completed on time.
Financial	Project over budget. Revenue model not achieved.	Proven data center delivered within on time, on budget. Revenue model achieved.

construction process, there was time to develop and build a solution that met the stringent commissioning specifications the developer required as well as develop a coordinated testing schedule that enabled the facility to be commissioned as a total system vs. independent and disparate components. This proactive approach enabled Enterprise B to fully validate design specifications and operational performance of the entire facility as a system, before the facility was operational. Simulation of data center operational thermal and electrical loads revealed several issues that were able to be cost effectively corrected while staying within initial schedule and budget.

Conclusion

Developing a comprehensive commissioning plan early in the design and construction phase helps ensure that all commissioning specifications are adequately planned for and met. Employing advanced load bank testing equipment and partnering with a respected equipment/services provider is essential to reducing overall data-center commissioning costs. By validating system design and performance before production, load bank testing ensures the operational success of a newly constructed data center and reduces the likelihood of costly post-production data center reconfigurations.

To learn more about how ComRent can help reduce commissioning costs and accelerate your commissioning schedule, visit: www.comrent.com or call us at 888-881-7118.