

Load banks and Data Centre Commissioning Tips, Field Notes & Best Practices

WHITE PAPER

Load Bank & Commissioning in Data Centers Sector

Introduction

Rentaload is a Load bank services company, based in France with offices in the UK and Germany, covering projects across the whole of Europe. Rentaload leverages its partners many years of experience in manufacturing load banks and as a result, offers its clients rental and services solutions for resistive, inductive and capacitive load banks, built and optimized specifically for **datacentres**. Rentaload provide banks, accessories, and services such as set-up de-mobilization, assistance in commissioning, commissioning for multiple applications all over Europe: testing diesel generators, acceptance testing for server rooms, dummy load, unloading, etc.

In this white paper we're going to share some tips, field notes and best practices relating to the use of load banks in **data center commissioning**. This white paper will be of interest to Data Centre Managers, New Build Project Managers, Commissioning Engineers, Power and Cooling Suppliers and specialist data centre consultancies.



Summary

A load bank is a device that develops an electrical load, that is then applied to an external electrical power source which then converts or dissipates the power output of the source. Load banks generally come equipped with protection circuits, controls and metering and ancillary devices used for their operation. They can be used to test AC systems, UPS, Generators and Batteries. They are considered to be the best way to commission, prove and verify the operation of mission critical power and cooling systems.

Their use in the data center environment is thus essential.

General Building Tests

All buildings undergo commissioning or tenant checks prior to the new owners taking possession or new tenants moving in, these checks ensure that all building systems (fire, security, environmental, and IT systems) are working and meet the required specifications.

In mission critical data centers these checks are of paramount importance, and load banks are used to verify the operation of critical systems at 3 of the 5 stages of the total IST processes to fulfil Global Certification Bodies requirements for IST's.

Load banks are used to verify functionality for AC and Power Systems, individually, and combined as part of IST.

[TIP: IST's can take up to 3 weeks, depending on the test schedule, ensure that you have sufficient budget for testing]

Field Note: Rentaload are being retained by end user clients to test potential sites for selection purposes, we always ask to see the original IST test sheets and final IST report (if available) and include this information back to our end user clients

Cooling Systems

ASHRAE recommend a temperature range of between 18-27°C and an allowable range of between 5-45° (depending on class and other conditions as specified in the ASHRAE TC9.9 documentation)

[TIP: Always use the latest industry guidelines for design and operation and thus the IST of data centres]

Your load bank operational ranges and placement should be able to replicate a range of temperatures, and to ensure the correct test parameters for efficient operation of cooling equipment, be able to replicate a range of supply and return temperatures, with at least a ΔT of 15°

Load banks are used to test the functionality of cooling systems but problems in the validity of the tests can arise depending on the test configuration. The test configuration should replicate as close as possible the intended full design cooling load of the data centre.

[TIP: Conduct Cooling tests for design capacity]

Field Note: Rentaload assisted a client to realise the design capacity testing schedule prior to the installation of racks and containment systems by constructing a temporary aisle test configuration

Air Flow Direction

Hot air rises, yes? But not necessarily true in a data centre environment, where we can find horizontal air streams, due to the confinement of the IT equipment in racks and the server manufacturers designing to draw air through the front of the equipment and exhaust it at the rear.

As a result, your load banks should be able to provide horizontal air flow, this will identify any potential hot spots and ensure that airflow testing with replicate real life conditions

Best Practice: Test at different loads throughout the design, minimum loads should be 25%, 50%, 75% and 100%, but you can test at any increment in conjunction with your expected load and build out period.

Power Systems

A load bank test replicates real operation by applying the load in situ, with real temperatures and relative humidity. The load bank only draws power (current and voltage) to test the infrastructure, and then dissipates it safely as heat.

Load banks are thus used to simulate the IT power load, but as with temperature, this tends to only test a fixed load, requiring multiples of test rigs, if higher than normal rack densities are required. It also doesn't replicate the varying power and heat that actual IT loads will generate.

That said, the use of load banks can provide good estimates of the equipment's characteristics in controlled settings with very high accuracy

Many organisations offer load banks of all shapes and sizes, and with varying characteristics and options, for sale or rent.

TIP: Select a LOAD BANK company that can provide a range of options that tests both temperature and power draw capabilities for the range of IT environments that can be experienced.

Rentaload offers rental of the first 6kW variable air flow load bank with power source converter 100% on line A, 100% on line B or 50% on line A & 50% on line B. With 2 possible supply sources, this load bank makes it possible to test the changeover from a main supply channel to an emergency route or to share the load between 2 sources.

With a precision of 500W, the rack load bank is the most accurate on the market

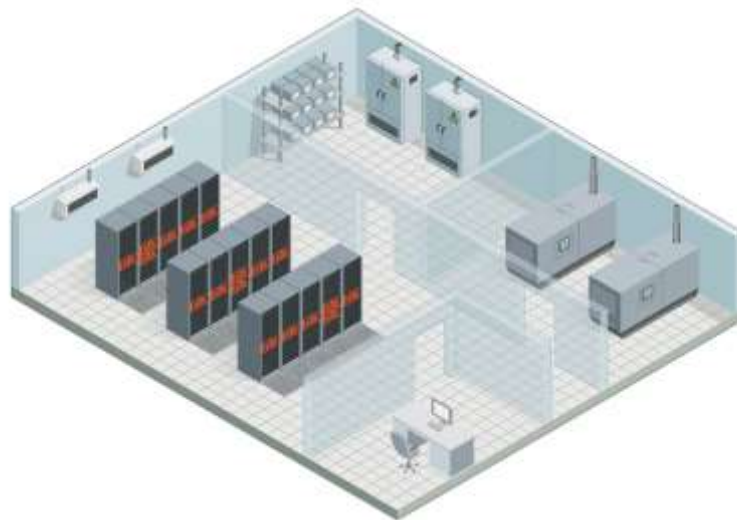


Picture of Rentaload smart rackable load banks (6 kW and 7 kW)

[Tip: Using load banks with integrated ATS dual power feed capability can reduce testing time as they can test A/B sides virtually simultaneously, and can be configured for 2N+1 data centre configuration

Field Note: The use of connected load banks combined with an efficient monitoring system (software based) will reduce IST testing time and provide more accurate results.

Best Practice: Use a range of load banks to test all power configurations



Integrated Systems Testing

Planning

It's never too early to start planning for your IST, and many data center construction projects adopt a 5 stage IST process, being, factory witness testing, site acceptance testing, pre-functional testing and start up, functional performance testing and then integrated systems testing. Load banks can be used for the last 3 stages.

[Tip: Get your load bank supplier engaged as early as possible to assist in the planning of the tests and to book equipment.]

Best Practice: As per EN50600 3-1, it is essential that FM or DC Managers are involved in the IST.

Installation

As the time available for IST may be limited, it is good practice to ensure that the load banks are easy to deploy in all possible modes and test configurations.

Typical scenarios for IST commissioning are prior to the installation of the racks and aisle containment and this can mean that the results are not an accurate representation of the original design.

To reduce energy costs for data center cooling, hot and cold air are often separated by enclosing opposing server rack rows. Without this separation the forced-air cooling units would intake a mixture of cooled supply air and hot exhaust air. As a result, the temperature difference over the cooler would be smaller and its effective performance lower as explained by the following equation.

It results from the thermodynamic relationship with the physical quantities of required air volume, heat load to be dissipated and necessary temperature difference:

$$V_I = \frac{Q_o}{\varphi_{air} \cdot C_{p\ air} \cdot \Delta T}$$

Constant values are the air density φ_{air} 1.185 kg/m³ and the specific heat capacity $C_{p\ air}$ = 1,0045 kJ/kg/K. The dissipated heat load Q_o is considered to be fixed.

It can be seen from the equation that if the temperature difference doubles from 10 K to 20 K, the required amount of air V_I can be halved.

Some test configurations place load banks adjacent to the cold aisle tiles to generate the hot thermal air streams but these fail to replicate the realistic air flow patterns caused using cold (or hot) aisles and/or containment.

The optimum way to test the final design is to replicate the hot/cold aisle configuration by the installation of a temporary aisle containment system, this allows the load banks to be positioned at various heights above the floor, which will more closely resemble an actual IT installation.

Testing with temporary aisle containment, and with load banks with variable temperature and power draws operation will better replicate real life configurations, both for initial IT equipment installation in the weeks following a successful commissioning, and in the future when equipment is replaced or expansion takes place.

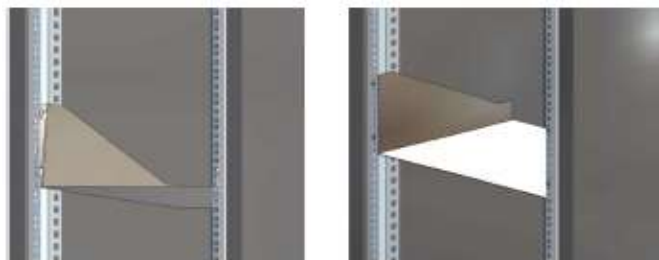
Such temporary aisle arrangements, should be prefabricated and modular, able to be installed without tools, be non-flammable, be airtight and provide the insertion of the load banks at different heights as required.

Field Note: Rentalload offer toolless shelves and ceilings that align with the proposed rack layouts or contained systems (we will need the design drawing to ensure that the toolless shelves/ceilings are an accurate reflection of the proposed design).



On-site pictures of a temporary containment – Paris / July 2018

The benefits of using toolless shelves/ceilings are a better test of the final layout and IT equipment fill, we also provide temporary aisle configuration services, and Load bank IoT



Drawing of toolless shelves

Validation

Rentalload, in conjunction with our partners Ekkosense can provide design validation by analysing the projected design airflow conditions which can be validated during the test.

[Tip: Use Computational Fluid Dynamics software to design your data centre, and then validate in real time using the Smart rack load bank in conjunction with CFD suppliers]

Certification

Every data centre certification programme globally will use IST test results as a qualifying criterion in their assessment.



« Commissioning tests guarantee to Data Center owner a better infrastructure reliability» ASHRAE ¹



« Tier homologation needs high level tests (IST Commissioning) » Uptime Institute ²



« A critical aspect of this handover is acceptance testing to ensure that the constructed facility matches the original design intent » CENELEC³

In Europe, EN50600 3-1, being the *Information technology — Data centre facilities and infrastructures Part 3-1: Management and operational information* standard, together with the rest of the EN50600 series is rapidly becoming the only standard that is relevant for data centre design, build and operations across Europe. It should also be noted that this series is also under consideration by the ISO for use globally under the TS22237 series. A TS is a technical specification, and this is considered to be an enhanced consultation document for further debate prior to full standards classification.

EN50600 3-1 states in Section 6, that *“Handover to operations are described as phase 11 of the design process in EN 50600-1. A critical aspect of this handover is **acceptance testing** to ensure that the constructed facility matches the original design intent.*

*There is a unique opportunity for **extensive acceptance testing** of the infrastructure prior to the first implementation of IT and the connected starting point of productive operation of a data centre. Cross domain tests can be carried out only during pre-production phase. All test results shall be documented.*

It is strongly recommended to involve operational personnel in acceptance tests.

Documentation shall be provided by vendors and suppliers of infrastructure prior to start of tests.

No responsibility for “completed” construction areas should be undertaken by the site Operations

Management without the formal acceptance of the area according to defined criteria. These should include the following:

- a) **a full commissioning programme has been successfully completed up to and including Integrated Systems Testing (IST) with all commissioning records fully updated;**

[TIP: Commissioning records should include Voltage, current, power and the delta T, the difference between incoming cold air and outgoing hot air, should be reported in an easy to exploit file, like a csv-file.]

Field Note: Rentaload have access to independent consultants who are committee members that wrote and continue to amend the EN50600 series and can offer independent advice on all aspects of data centre construction and operations

b) all required training has been completed;

c) Operations Management should not undertake any management responsibility until they have satisfied themselves that the systems are working through acceptance testing and are able to be properly maintained;

d) Operations Management should have the opportunity to recruit and train staff well before live operations commence. Ideally the core staff should be present during commissioning;

e) the following documentation should be made available prior to handover into live operations:

1) up to date and accurate "As-Built" records and drawings including engineering single line diagrams;

2) a full set of Operations and Maintenance manuals, including Standard Operating Procedures, Maintenance Operating Procedures, Emergency Operating Procedures, escalation procedures etc.;

3) comprehensive commissioning records;

4) an up to date and accurate Asset Register;

5) a documented Planned Maintenance Schedule and a full set of maintenance records;

6) all documentation required for compliance with statutory regulation;

7) all documentation required for compliance with voluntary standards and certificates.

[Tip: Advise your load bank provider that you will be seeking certification for the site and may require additional commissioning documentation]

Best Practice: All test data should satisfy the advantages of undergoing comprehensive commissioning tests, these include: Testing over a period of time to verify system performance as designed, without risk to mission critical IT loads, to reduce critical infrastructure early equipment failure rates, the opportunity for maintenance and operations teams to get hands-on equipment experience, the opportunity to verify detailed written procedures that will govern live facility maintenance and operations, it will be the only opportunity to test the facility limitations and to avoid down time.

Source directory :

1. American Society of Heating, Refrigerating and Air-Conditioning (ASHRAE), IST Commissioning Standards
2. Uptime Institute, conférence Professionnal Services Tier Certification, IST Commissioning, Novembre 2013
3. CENELEC: EN50600-3-1
4. Bernd Dürr, IT-Räume und Rechenzentren planen und betreiben, 2.Auflage, 2018

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