Data Center Projects: Commissioning

White Paper 148

Revision 1

by Dennis Bouley

> Executive summary

Failure to properly commission a data center leaves the door wide open for expensive and disruptive downtime that could have been avoided. Integrated commissioning of all physical infrastructure components assures maximum data center performance and justifies the physical infrastructure investment. This paper reviews the desired outputs and identifies the standard inputs of the commissioning data center project step. The commissioning process flow is described and critical success factors are discussed. The commissioning process inputs and outputs are also placed in context with other key data center project process phases and steps.

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Introduction

When building a new data center, the owner of the data center has no guarantee that the various physical infrastructure subsystems – power, cooling, fire suppression, security, and management – will work together. Commissioning is the process that reviews and tests the data center's physical infrastructure design as a holistic system in order to assure the highest level of reliability.

Traditional commissioning is a daunting task. Since formal system operation doesn't begin until the system is commissioned, the commissioning team experiences intense pressure to complete the commissioning process quickly. Commissioning can involve high expense and requires staffs from different departmental disciplines to work together. For these reasons data center commissioning has almost uniquely been associated with large data centers (over 20,000 ft^2 or 1,858 m^2). In the recent past, many data center managers chose to roll the dice and perform little or no commissioning, relying only on start-up data to press ahead with launching the new data center. Given the reality of 24x7 operations, however, the alternative of exposure to major system failures and accompanying downtime is no longer an economically viable option. Commissioning has now become a business necessity.

Data center project phases

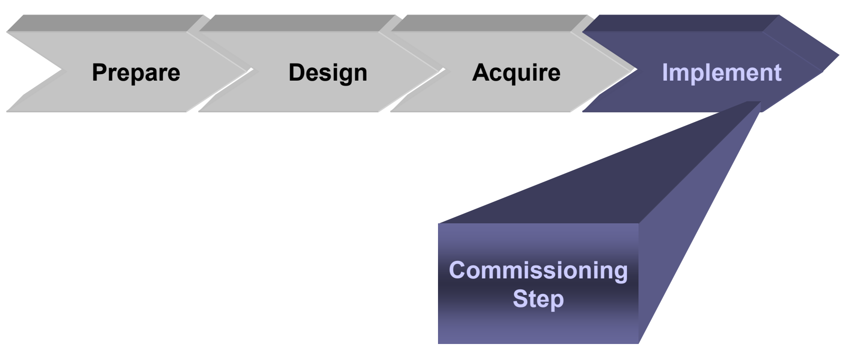


Figure 1

Data center design / build project process

Placed in the context of an entire data center design / build project, the commissioning step is part of the implementation phase (see **Figure 1**). Within the implementation phase, commissioning comes after the physical infrastructure systems have been delivered, assembled, installed, and individually started up. Once commissioning is complete, formal orientation and training of data center staff can begin. For a complete overview of the data center design / build project process, see APC White Paper 140, *Data Center Projects: Standardized Process*.

Related resource
APC White Paper 140
Data Center Projects: Standardized Process

Definition of commissioning

Commissioning is defined as a reliability science that documents and validates the result of a data center's design / build process. The roots of commissioning can be traced to the many independent equipment vendors who, over the last 10 years, provided "start-up" services after having installed their particular data center system component. Each start-up process was driven principally by contractual requirements that operated in a vacuum, independent of other components. The general contractor hired various equipment vendors to supply and install their products. These vendors were guided by a construction installation schedule. When each vendor completed their particular product installation, they requested a certificate of completion from the construction manager. The certificate served as proof that the contracted systems were installed and made operational, and only then was the vendor's request for payment authorized. However, no contractual requirement existed for the disparate products to perform in a fully integrated manner.

The practice of commissioning an entire data center developed when standard equipment start-up procedures consistently failed to identify system-wide weaknesses (see **Figure 2**). A data center manager who avoids the time and expense of commissioning has no ability to effectively judge the data center's ability to handle the intended critical loads.

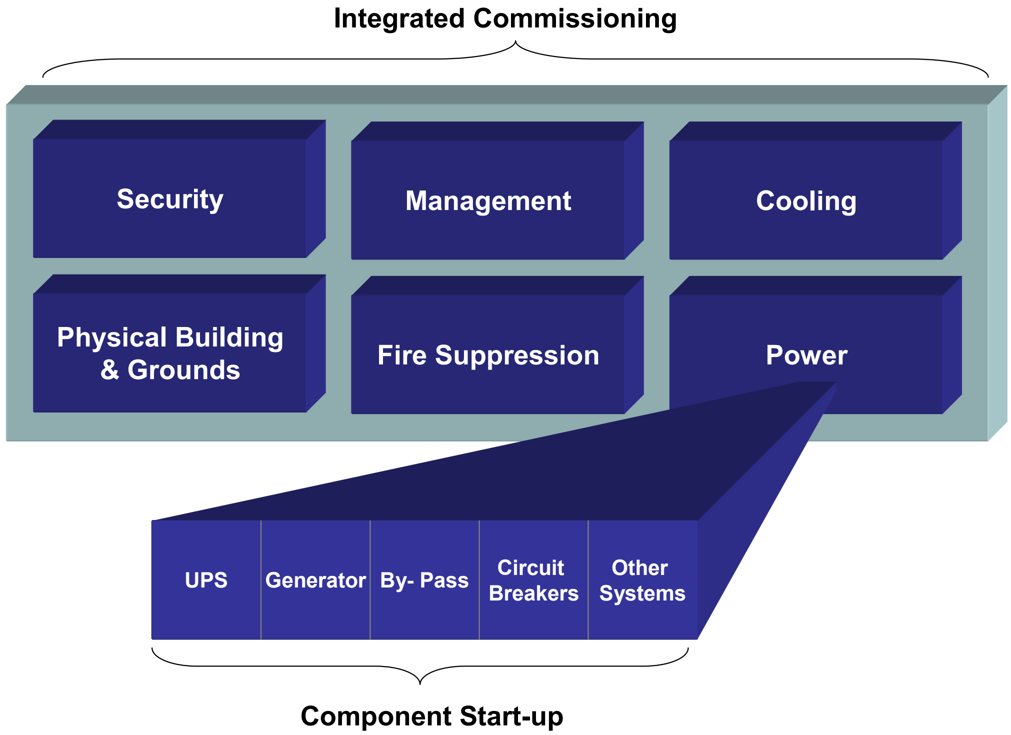


Figure 2

Product focused start-up ignores the proper integration of key subsystems

Detailed commissioning is most often performed for medium and large "green field" (new) data centers. Smaller data centers with mission critical applications can also improve overall data center performance from proper commissioning, although cost may be a factor.

A supplemental resource for companies considering data center commissioning is *ASHRAE Guideline 0 – the Commissioning Process.* This document provides an overview of commissioning, description of each commissioning phase, requirements for acceptance of each phase, requirements for documentation of each phase, and requirements for training of operation and maintenance personnel. For best practices information, consult APC White Paper 149, *Ten Errors to Avoid When Commissioning a Data Center*.

Related resource
APC White Paper 149
Ten Errors to Avoid When Commissioning a Data Center

Outputs of commissioning

The knowledge gained from the commissioning exercise should be documented. The following three documents need to be produced if the commissioning process is to yield some tangible benefits:

1. "As built" script report
2. Component error log report
3. Trending report

"As built" script report

The "as built" script report highlights the specific system components tested, describes what kinds of tests were performed, and provides a line by line account of how each component either passed or failed the test. The "as built" script serves as an important reference document when, in the future, failure analysis is performed. The example below outlines the "as built" script report content:

Figure 3

Sample "as built" script report outline

1. Data center description
- A. size in sq ft / sq meters
- B. key physical infrastructure components
- C. component redundancy levels
- D. overall data center criticality level

2. Data center design criteria
- A. Physical floor plan demonstrating physical infrastructure equipment locations (includes racks)
- B. Floor plan denoting power distribution
- C. Floor plan denoting coolant, chiller and fire suppression piping
- D. Floor plan with existing air flow patterns

3. Component verification
- A. model specified (manufacturer, model name, model number, asset ID number)
- B. model delivered (manufacturer, model name, model number, asset ID number)
- C. model installed (manufacturer, model name, model number, asset ID number)
- D. model capacity (kW, volts, amps)
- E. general equipment condition

4. Performance data
- A. test procedures
- B. expected response
- C. actual response
- D. designation as pass or fail

Component error log report

The component error log, also known as Failure Mode Effects Analysis (FMEA), focuses on the specific system components that failed the tests and documents how the failed test impacted other components either upstream to or downstream of the component in question. This report details the performance data results, highlighting errors that have occurred and recommending solutions. Below is an example of the categories of information presented in a component error log report.

Table 1

Example of component error log report

Test area / procedure no. / and sequence ID	Failure / reason for failure	Impacted system	Corrective action
Test area: power **Procedure: 21** **Sequence: 12**	**Failure:** UPS failed to support load after switching from by-pass mode to full function. **Reason:** Battery leads at the head of battery string were disconnected	Generator, Load Banks and battery banks	Have chief electrician verify that all battery leads are properly connected and rerun test.
Test area: cooling **Procedure: 38** **Sequence: 3**	**Failure:** Chilled water failed to circulate to CRACS **Reason:** Pump located between condenser and CRAC failed to start	Chiller, CRAC, Condenser	Have facilities engineer replace pump with spare unit until new unit can be installed.
Test area: fire system **Procedure: 42389** **Sequence: 8**	**Failure**: Smoke detector A6 failed to raise alarm when tested **Reason**: Faulty sensor near intake	Air distribution system, Sensor aggregation point, Smoke detection unit.	Contact vendor to replace smoke detection unit

Commissioning is an ongoing process. Once all operational parameters have been verified and all settings have been checked, the commissioning documentation serves as a benchmark for monitoring changes and trends in the data center.

Executive summary / trending report

Once actual commissioning is completed, a trending report is issued. This report includes a management summary of identifiable system performance trends. The summary also contains a high-level system description, highlights issues that were encountered and resolved, and identifies issues that remain open for future action. The summary also includes an action plan and a validation statement from the commissioning agent verifying that the data center has fulfilled the company's design expectations. This report synthesizes the data gathered from both the "as built" script report and the component error log report. Below is an example that outlines the content of a commissioning trending report:

Executive summary
1. Data center overview
2. Summary of pre-commissioning data (i.e. component start up data)
3. Summary of commissioning scope

Commissioning methodology overview
1. Procedures tested
2. Sequence of testing

Data center commissioning system performance trends
1. Includes data center physical infrastructure power input and heat output
2. Projected energy consumption report with both energy-use index (EUI) and energy-cost index (ECI). The EUI is kW per air conditioned sq foot of the data center. The ECI is dollars per conditioned square foot per year.
3. Analysis of error logs, with emphasis on root causes.

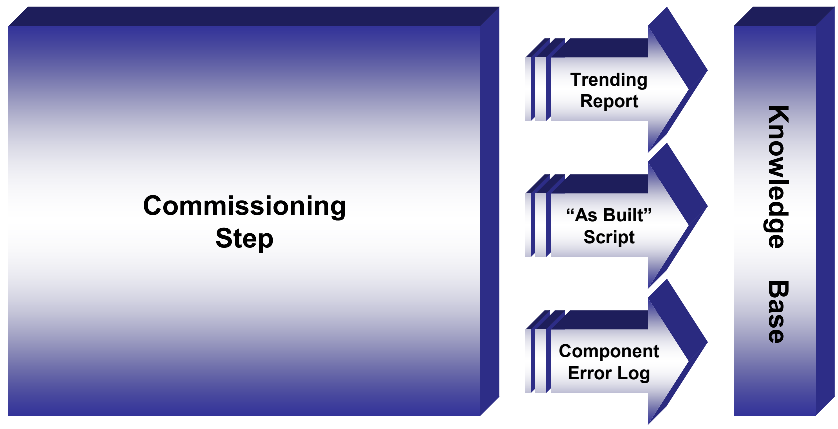
Conclusion
1. Possible impacts of future expansion

The commissioning documents should be placed into the data center's library of procedures and practices (**Figure 5**). It is important that the acquired knowledge be documented in a formal company system and NOT merely in the possession of one or two individuals who might leave the company.

If the commissioning knowledge base is automated, then it can serve as a valuable training tool for vendors and new staff members who are installing new pieces of equipment. IT help desk and on-site facilities departments can also use the commissioning data for training. More advanced training can include a requirement that staff be knowledgeable in commissioning test results. In fact, the ability to run commissioning tests could be used as criteria for attaining internal technological performance certification levels.

Figure 5

Commissioning outputs should be fully leveraged



Typical utilization of commissioning data includes the following:

- Comparison of future performance against known day-one performance (trending)
- Training of site staff (i.e. video tape recordings of critical procedures that will need to be performed in the future)
- Clarification of root causes of future failures (forensic analysis)
- Verification of warranty claims, performance assurance claims, and for other insurance purposes
- Support data for risk assessment analysis
- Benchmark data to evaluate overall system performance
- Identification of system components that need to be either redesigned or retuned
- Prediction of expected results from system events

The commissioning knowledge base should also be used by senior management to estimate the future usability and life expectancy of the data center.

Inputs to commissioning

Commissioning is initiated as a result of several related processes that are executed in advance. These key inputs include the following:

1. Data center site preparation and installation work
2. Component start up data
3. Data center design parameters

Data center site preparation and installation work

Site coordination assures that installation prerequisites have been identified, verifies that all system requirements have been met, reviews electrical and cooling installation requirements with appropriate subcontractors, and verifies the floor layout design. This is followed by actual installation of the physical infrastructure equipment components.

Component start up data

Both data center staff and equipment vendors are responsible for the task of starting up individual system components. Once a piece of equipment, like a UPS for example, is delivered and installed, the next logical step is to perform the start up. Start up generally consists of powering up the system to make sure that the new equipment component is working properly. The results of these various start up tests need to be made available to the commissioning team prior to the initiation of the commissioning process. The team must then decide how much commissioning will be required to provide a sufficient integrated test (see **Table 2**).

Table 2

Sample commissioning scope checklist

Power tests	Cooling tests	Fire suppression and security tests	Infrastructure monitoring systems and controls tests
__ System grounding	__ Chillers	__ Pipes	__ Power monitoring system
__ Generator	__ Chilled water pumps	__ Sprinkler system	__ CRAC monitoring system
__ UPS	__ Cooling tower	__ Gauges	__ Humidity sensors
__ ATS	__ Condenser water pumps	__ Pumps	__ Motion detection sensors
__ Integrated power system	__ Piping	__ Automatic alarms	__ Temperature sensors
__EPO	__ Heat exchanger	__ Smoke detection	__ Building management system
	__ CRAC	__ Electronics	
	__ Ducting / air flow	__ Man trap	
	__ Integrated cooling system	__ Door lock system	
		__ Security camera	

Data center design parameters

In a traditional data center design, the data center designer takes the operational assumptions (i.e. 5,000 foot, tier II with 10% annual growth), and then custom designs the data center physical infrastructure using custom components. The designer consults colleagues to verify accuracy and to make redesign corrections, and then issues final designs. The design process includes estimations, custom parts, and redesigns – all of which invite multiple errors by increasing complexity. This traditional approach, with all the high risk and high costs it introduces, discourages many data center managers from investing additional dollars to properly commission the data center.

Modern data center design takes a different approach. A detailed analysis involving power density, criticality levels (comparable in part to data center "tier" levels), power and cooling capacity planning, and data center growth plans sets the stage for establishing the design.

These design parameters are ultimately expressed in the format of a floor plan. The floor plan allows for the commissioning team to formulate a strategy for scripting and testing the integrated system components (see **Figure 10**).

Related resource
APC White Paper 116
Standardization and Modularity in Data Center Physical Infrastructure

Fortunately, recent innovations in physical infrastructure technology – such as scalable, modular power and cooling components – have helped to introduce standardized components into the design process. Standardization of both products and processes creates wide-ranging benefits in physical infrastructure that streamline and simplify every process from initial planning to daily operations. For more information on the availability, agility, and TCO benefits of physical infrastructure standardization, see APC White Paper 116, *Standardization and Modularity in Data Center Physical Infrastructure*. With standard system components in place, commissioning becomes a less daunting, more affordable, and higher-value task that can be employed in both small and large data centers.

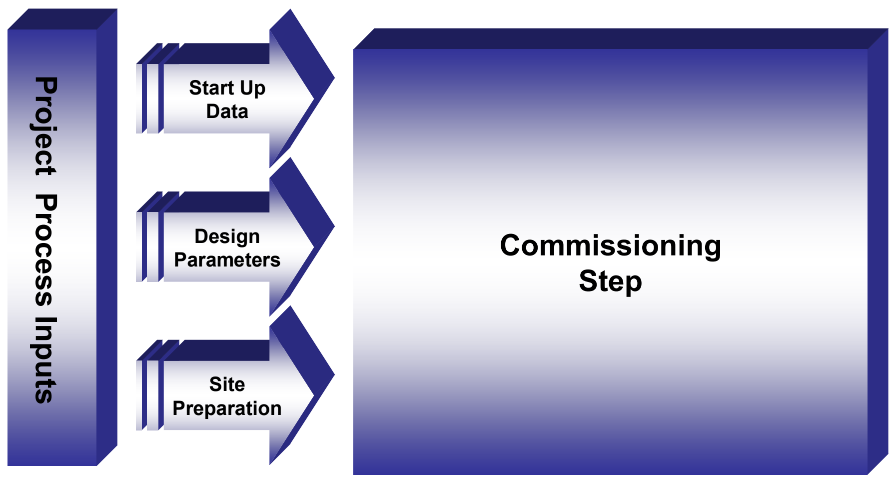


Figure 6

Both internal and external resources provide inputs to commissioning

How commissioning works

Commissioning helps to compare *actual* system performance to the performance *assumed* by designers as they architected the data center. The essence of commissioning is "reliability insurance." The main purpose of traditional insurance is to lower the liability should an incident occur in a home or business. Commissioning lowers the risk of failures in the data center by making sure, ahead of time, that the system works as an integrated whole. It also can demonstrate how the equipment and systems perform during failure scenarios.

To determine the value of commissioning, data center managers need to take into account whether the cost of downtime is greater than the cost of the commissioning process. According to Einhorn Yaffee Prescott (EYP), a global consulting engineering firm, a good rule of thumb is to invest 2% of the overall data center project cost on commissioning. In most cases, data center owners will see a 5-10% ROI benefit in terms of overall data center performance as a result of commissioning.[1]

Commissioning process

Key commissioning processes include the following:

1. Planning
2. Investment
3. Selection of a commissioning agent

[1] Einhorn Yafee Prescott, Data Center World, *Everything You Need to Know About Commissioning,* March 2006

4. Scripting
5. Setting up of a command center
6. Testing
7. Documenting

Planning

The commissioning process begins months ahead of the actual delivery of the physical infrastructure equipment. Regular commissioning meetings should be held several weeks ahead of the actual commissioning date. Vendors of the various component subsystems should provide start-up documentation as part of the planning process. At these planning meetings, primary and secondary stakeholders are kept informed of how the commissioning schedule will be organized. Plans can be formulated at these meetings to set up event sequencing and to coordinate schedules. The responsibilities of the team members who are engaged in the process should be clearly defined in the planning stages.

Commissioning strives to identify and eliminate as many single points of failure (SPOF) as possible. The new facility, or “green field” facility, makes it easier to control all the moving parts of the total data center environment. In a green field data center all engineering and operational assumption data is fresh and obtainable. In addition, needs and constraints are understood and key personnel are accessible. For instance, a need would be for the facility to have 5 minutes of battery back-up time while a constraint would be that generators should not run for more than 30 minutes.

An existing or “brown field” facility presents more limitations than a green field facility. In a brown field data center, original commissioning documentation may only consist of component start-up information. The original engineer of record may not be available. Landlords or lease agreements may have changed. The general contractor’s records may be partial or unavailable. Subcontractor and vendor documentation may be outdated and possibly faulty or unavailable. Internal management and / or original stakeholders may have changed. The company may have been involved in a merger or acquisition scenario. Simply stated, it is unrealistic to have the same expectations for an existing data center commissioning project as for a green field project. These complicated commissioning scenarios should serve to reinforce the importance of automating, up front, the documentation development, storage, and retrieval processes.

Four years is the average refresh time for a green field data center to experience a major upgrade project. Therefore, it is important to implement commissioning best practices at the outset. If the existing data center history has been properly documented, it can serve as base-line data for the new data center. In addition, all tracking records can serve as input to the new design. Former project cost documentation of the existing data center can also be revised for accurate budgeting of the new data center, and existing and new equipment reliability can be accurately predicted. The entire past commissioning investment can be leveraged for the new design / build project.

Investment

Determining how much commissioning should be performed depends on the business expectation of cost and need. The more thorough the past commissioning process, the faster and less costly future commissioning projects will be. Commissioning comes back to playing the role of an insurance policy for data center reliability. With life insurance, for example, the older the individual the more he or she will pay for a certain level of insurance. The “right” amount to invest is directly proportional to how old the data center is. To fully commission a ten year old data center is possible. However it may be more cost effective to consider a complete replacement of the existing data center.

Selection of a commissioning agent

Many different viewpoints and influences impact the ultimate selection of the commissioning agent. When engaging a commissioning agent in medium to large organizations, a recommended best practice is to assure that the commissioning agent is independent. This practice is driven by an organization's desire to enhance its corporate image by leveraging independent validations.

Finance departments embrace a similar approach regarding the independence of outside auditors. Most companies subscribe to generally accepted accounting principles (GAAP). GAAP requires the engagement of an independent audit agency to validate all public financial data. The audit agent is not permitted to maintain any secondary relationships that could compromise the independent review. Most companies' internal audit requirements mandate that the commissioning agent conform to the same rigid practices that are imposed on the finance department. The reasoning behind this practice is that validation statements derived from the data center commissioning process are used in risk assessment by investors and that these commissioning documents may become public record.

If a company or owner chooses not to engage an independent commissioning agent, the design engineer or the construction company can usually perform the commissioning process. Regardless of whether an external or associated commissioning agent is selected, validation of the agent's past experience in delivering a fully integrated commissioning process is recommended.

Once the contractor team has been selected by the owner, the commissioning agent should get involved early in the project process. Early engagement provides the cleanest, least filtered information and enhances the ability of the team to identify potential single points of failure (SPOF). Involving a commissioning agent early on also reduces the possibility of having the commissioning process fall victim to budget cuts, should the project experience cost overruns.

Scripting

Prior to the integrated testing of equipment, a comprehensive test script must be created. Scripting is important because it provides a time-sequenced and order-based roadmap for testing all key data center elements. The script also captures a record of all the test results. By following the script, the commissioning team can observe and validate how each physical infrastructure component influences the operation of linked components.

The scripting is usually performed by the independent commissioning organization. If a company or owner chooses not to engage an independent commissioning agent, then the design engineer or the construction company can perform the scripting process. The master script is developed over the entire length of the construction process and refined for each physical infrastructure element.

Scripting must first validate that all subsystems are tested using the manufacturer's start-up process. Vendors of the various component subsystems should provide start-up documentation and have it added to the script well in advance of the commissioning dates. Regular scripting meetings should be held prior to the actual commissioning date. At these meetings, the general scripting progress is reviewed and revised for each physical infrastructure subsystem. When all the independent subsystems have been scripted, they are incorporated into a cohesive *system* script.

Once the various start-ups are validated and the assorted scripting documents are in order, the integrated testing process can begin.

Setting up of a command center

Depending upon the complexity and size of the integrated commissioning test, a command center may be required. Smaller data centers may simply designate an individual who can act as the command center – a communication "hub" – during the testing process. The purpose of the command center is to coordinate various testing activities, to give next step testing permission, to handle all internal and external communication, and to have all contact and emergency phone numbers available.

It is vitally important that the individuals actually performing the commissioning task not be overburdened with external communication and documentation details; this is the command center's responsibility. The testing group needs to focus on safety and testing.

Figure 7 is an example of a typical communication between command center personnel and the commissioning agent. This example emphasizes the importance of the time sequencing of events and the level of precision required during the commissioning process.

Figure 7

Typical command center communication example

"Commissioning Agent (CA) to Command Center (CC): do I have permission to open CB #102, Script Test line EE15, Time 01:05?"

"CC to CA: Please hold until I verify with IT Help Desk and Engineering, Time 01:15"

"CC to CA: I have verified, permission is granted; Time 01:34"

"CA to CC: CB # 102 is OPEN and Lock Out / Tagged Out engaged, Time 01:40"

"CA to CC: do I have permission to proceed to Script Test line EE 16, Time 01:45?"

"CC to CA: Yes, proceed to Script Test line EE 16, Time 01:47"

Note that the time stamp on each command center communication can be used to help refine the execution of the task in the future. The command center process ensures that the script is followed and that shortcuts are not taken which could lead to latent defects and subsequent downtime.

The element of human fatigue must also be considered. In a perfect world, everyone in the commissioning process would be well rested and alert, but this is not always the case. The command center must ensure that only well rested individuals are included on the commissioning team. If not, the possibility for human error grows dramatically. Several approaches can help limit the fatigue factor of the employees:

- Consider scheduling the commissioning test phases during the day as opposed to late at night.
- Monitor the number of hours that staff members are involved in testing so that work shifts can be appropriately rotated.
- Avoid having staff members work on weekends, particularly if they have been involved in testing for several intense days in a row.

Testing

Every piece of equipment should be tested by executing a sequenced failure followed by a restart and return-to-stable operation. A sequenced failure implies that a failure in one component (such as a generator) is communicated to a second related component (such as the air conditioning system) so that the second component can act in an appropriate manner to minimize downtime or to be ready for action when power is restored. This testing cycle should be performed on each component and also on the entire integrated system. This will involve a complete power down and an automatic restart.

Power: This aspect of the commissioning process tests the high voltage electrical service entrance. It then progresses forward to the medium voltage main power distribution system, including parallel switchgear, transfer switches, emergency generator, UPS system, the data center monitoring system, and the distribution down to the racks. All lighting and life safety systems including emergency power off systems (EPO) are also tested. Finally, electrical system commissioning should include a short-circuit and breaker coordination study using electrical scripting to verify that *all* circuit breaker and ground fault trip settings are correct.

Cooling: The cooling components include the cooling towers (including incoming water sources), chillers, piping, pumps, variable speed drives, chemical or other water treatment systems, and filtration systems. It also includes building humidification, ventilation, heating systems, and computer room air conditioners (CRACs).

Fire suppression: This begins with an analysis of the incoming water and post indicator valves (PIVs), works through the alarm systems and automated reporting systems, and ends with the sprinkler and or clean agent (gas) fire suppression systems.

Monitoring and management systems: Commissioning of the building management and energy management monitoring and control systems is incorporated with each primary system test. Each alarm should be verified.

Physical security systems: The central security station site video monitoring, physical security devices such as mantraps and card readers, and central sound system are also tested during commissioning. All wall duct penetrations should be double checked to determine whether security bars have been installed. These security bars can prevent an intruder who has gained access to the roof, for example, from entering the data center by climbing down a large air duct.

Spare parts: If deploying some of the newer, modular / scalable UPSs or similar equipment, spare parts, such as backup power modules, should also be included as part of the commissioning process. For example, the original power module should be included in the first test. Then that module should be pulled out and replaced with the spare module. The test should be run again to verify that both the original and spare modules work correctly. The spare module should then be properly stored (i.e. wrapped in a dust resistant plastic package) in a secure environment until it is ready to be deployed as a replacement part.

Tools

Commissioning tests the “sequence of operation” of all systems working together, and tests and documents the limits of performance. During commissioning, automatic failure and recovery modes are also tested and documented to assure that redundancies work.

Although physical infrastructure equipment is installed prior to commissioning, data centers are not often fully loaded with IT equipment during commissioning (see **Figure 8**). Therefore, a sufficient heat load may not exist for system testing. In this case, load banks can be used to introduce heat loads and to allow for simultaneous testing of both electrical and cooling systems.

Figure 8

Large load banks simulate computer load

Commissioning for high density

The traditional approach of utilizing load banks to simulate the data center's electrical load is both costly and insufficient for commissioning a data center in an integrated fashion. Traditional methods emphasize power conditioning systems. Mechanical systems, such as CRACS, are not tested to the same extent. The challenge with traditional load banks has been the difficultly in producing a heat load sufficient to simulate and test the operating limits of the CRAC systems.

Now that blade server technology is being introduced to many data centers, managing heat has become even more important. Blade servers can generate a load of 24 kW or more per rack.

Until now, no commissioning methodology has permitted the testing of power and cooling systems simultaneously. No methodology has allowed for the creation of an environment that could accurately test the level of power and cooling needed to support a true high density data center. American Power Conversion (APC) by Schneider Electric has developed an approach that allows end-to-end reliability testing to be performed easily and safely. Using a "server simulator" that installs in a standard IT cabinet or rack, the methodology duplicates IT loading both in terms of electrical load, heat and air flows (see **Figure 9**).

Figure 9

Rack-mounted server simulator has adjustable heat and air flow settings

The APC temporary independent resistive heaters can be installed in the data center racks as artificial server loads. These heaters have selectable load and airflow ranges that can be set to match the electrical server load and airflow designed for each rack. These heaters can be directly plugged into the same electrical distribution system installed to supply the servers; hence all distribution is also commissioned. The cooling, electrical and monitoring systems must be ready to run when the load banks arrive and when the functional tests are set to be run.

Temporary independent rack heaters test the following:

- Power distribution installation
- Hot / cold aisle air flow
- Rack hot air flow patterns
- Rack mount outlets in the racks
- PDUs serving the racks
- Management for the entire physical infrastructure system (including racks)

They are also useful in verifying the following:

- Actual rack cooling requirement
- Automatic shutdown parameters by verifying UPS and run to failure modes
- Computer room air conditioner (CRAC) system operations
- CRAC cooling fluid system

Scripting checklists

A second valuable tool utilized in the commissioning process is the scripting outline. In most cases the commissioning agent will use a standard master script outline that is modified based upon the system components in the particular installation. During actual testing, the script should be a hand-held paper or electronic document containing a test procedure articulating the projected outcome of each event. It should also contain check off boxes for each test with space for comments and test results (see **Figure 10**). Each person associated with the test should have an identical copy of the test script. The scripting documentation, if properly designed and assembled, is a powerful tool for the IT staff to utilize in order to proactively prevent future system failures.

Figure 10

Abbreviated example of closed-transition transfer switch test script

Line number	Check off box	Description	Results	Proceed?	Initials
132	✓	**Basic operational tests – manual transfers**	n/a	Yes	______
133	✓	(carry out the following functional tests)	n/a	Yes	______
134a	✓	ATS racked in "CONNECTED" position	pass	Yes	______
134b	✓	ATS not bypassed	pass	Yes	______
134c	✓	Closed-transition transfer capability disabled	pass	Yes	______
135	✓	**Test steps**	n/a	Yes	______
136a	✓	Verify that above conditions are satisfied	pass	Yes	______
137b	✓	Move ATS to "TEST" position	**fail**	**No**	______
137c	____	Bypass ATS to Normal source			
137d	____	Move ATS to "TEST" position			
137e	____	Move ATS to "DISCONNECTED" position			

Organization

In addition to testing and command center teams, it is important that key stakeholders are present when the commissioning takes place. If key team members can witness failures, they can provide more constructive feedback during remediation and retesting. The commissioning teams should consist of the following:

- Owner team (which can include representatives from the IT department, from facilities, from operations, and from key business units)
- Design team (which may include an architect / engineer from the outside, an interior designer, and any specialized consultants)
- Contractor team (which will include the contractor, the outside project manager, the inside program manager, and any significant subcontractors)
- Supplier / vendor team (independent product representatives)
- Independent commissioning agent

These stakeholders need to work in a coordinated fashion in order for the commissioning exercise to be successful. The commissioning agent leads the process and the owner and vendor teams typically perform the testing. Documentation is the responsibility of both the commissioning agent and the owner teams. The design and contractor teams are involved much earlier in the process, by providing inputs to the commissioning script and scheduling dates.

Conclusion

The data center physical infrastructure commissioning process can be compared to an insurance program. Like insurance, the owner must weigh the cost of commissioning to the risk of a potential loss. It is the principal stakeholder's responsibility to ensure that the initial benefits of integrated commissioning do not degrade over time. Similar to insurance, the commissioning agent should be contacted periodically or at major business events to provide a review of the integrated system's current integrity. This review is required because risk and reliability will change over time as business needs change.

Integrated commissioning produces volumes of well documented test results, procedures, and processes. The output of commissioning is the physical infrastructure knowledge base of your company. If kept current, commissioning documentation is invaluable in providing physical infrastructure refresher education and new hire training. If the information is electronic and automated, it can be used as valuable design input to future data center projects. Companies like APC can provide commissioning support services if required.

About the author

Dennis Bouley is a Senior Research Analyst at APC by Schneider Electric's Data Center Science Center. He holds bachelor's degrees in journalism and French from the University of Rhode Island and holds the Certificat Annuel from the Sorbonne in Paris, France. He has published multiple articles in global journals focused on data center IT and physical infrastructure environments and has authored several white papers for The Green Grid.

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