White Paper

Markets Served
Data centers

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Data center downtime: risk and cost avoidance through service

Executive summary

Preventive maintenance is crucial to achieve optimal performance from your equipment. Systematic inspections, testing and cleaning by trained technicians ensure the various electronic and mechanical components of a UPS are functioning to their maximum potential. When problems are detected and repaired before they evolve into significant—and often costly—issues, your UPS is able to deliver the level of performance you expect.

A variety of different UPS service options are available, including routine scheduled maintenance, emergency parts and labor service, and other value-added offerings such as remote monitoring. Regardless of the exact course of action you choose, an effective preventive maintenance plan will save time and money by minimizing business interruption and the costs of downtime, as well as enhancing your overall return on investment by extending the lifespan of your critical power equipment. Preventive maintenance is also crucial to achieving maximum performance from your equipment by affording the opportunity to detect and repair potential problems before they become significant and costly.

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Powering Business Worldwide

Downtime is disastrous

Downtime carries an enormous price tag, so it is critical to minimize interruption to your operations and to your customers' business.

Lost or corrupted files, hardware malfunctions, the inability to access the critical systems you need. All these unpleasant consequences—just a small sampling of the possible outcomes of unexpected downtime—can significantly impact your ability to conduct business. On top of that is the potential for lost revenue and damaged reputation in the event that customer service mechanisms such as online ordering, phone systems or other sales tools are unavailable to customers. In many instances, there is very little lag time between system downtime and financial disaster.

Multi-tenant data centers have unique uptime challenges

While any data center outage is damaging, the downtime downside is greatest in a multi-tenant data center (MTDC). A MTDC outage does not impact just a single organization, as a service interruption in a private data center would; it can affect several or even dozens of customers, depending on the size of the facility. The impact of downtime is multiplied in the MTDC environment.

There are unique factors in place that can increase the risk of downtime. In short, multi-tenant environments are complicated by factors such as:

- Diversity in environments due to variation in customer requirements leading to different architecture and design needs within the same facility
- Customers operating times and busy periods, which causes complications scheduling service interruptions
- Customers coming and going, sales tours, and other business activities leading to more guests, more people coming and going, and distractions to data center operations staff that can lead to a greater chance of human error

However, with an effective preventive maintenance plan, your business will have access to more reliable, higher quality and more cost-effective power, all of which minimize the risk of downtime and disruption.

Depending on the type of maintenance agreement you choose, trained technicians can even monitor the performance of your UPS and diagnose problems remotely, as well as respond to emergencies on a 24x7 basis, 365 days a year. In fact, if a downtime incident does occur and you have the proper service agreement in place, the problem may be fixed before you are even aware there was one. For example, consider a case where an older UPS that had a component failure and switched to bypass and was unable to protect the critical load. If unnoticed, everything could appear to be in working order for months until a fault happened with the utility and there was a load loss. Customers subscribing to remote monitoring mitigate this risk, as our remote monitoring technicians instantly receive the alarm and dispatch a service technician.

The most common causes of UPS failure

Batteries. The heart of any UPS, batteries require inspection and maintenance regardless of their age or warranty status. During a preventive maintenance visit, data is obtained from thorough testing procedures, during which impedance or conductance measurements trace the battery performance and identify any batteries showing signs of weakness.

Fans. Some fans fail because of their own electrical or mechanical limitations or when their ball bearings become dried out. Fans may perform well for more than 10 years of continuous use, while others run for only short periods before locking up or slowing down.

Capacitors. A capacitor is a fairly simple electrical device that stores and releases electrical energy. These devices can be as small as your thumbnail or as large as a soda can. A typical UPS contains a dozen or more capacitors of different types and sizes that smooth out and filter fluctuations in voltage. Like batteries, capacitors degrade over time. When a capacitor fails, there might not be any immediate visible effects, but other capacitors must compensate for the additional workload, which shortens their useful lives. Inspection of capacitors during preventive maintenance helps optimize their operation while also enhancing their lifespan.

Transient spikes. Damage may be caused to the input side of the UPS (filter/rectifier) when a transient spike occurs. During a preventive maintenance call, these parts are checked for any impairment.

Other factors that lead to UPS failure events include:

Lightning. A common misconception is that a UPS constantly protects the equipment load from lightning, but it primarily depends on the amount of energy in the transient. Preventive maintenance inspections can readily identify lightning damage and any appropriate repairs.

UPS internal connections. Vibrations from the building or machinery close to the UPS may affect these. It is recommended the UPS and battery cabinets be inspected for loose internal connections during annual preventive maintenance. Both should also be scanned every three years for hot spots.

Air filters. Because dust may block air filters and cause a UPS to shut down due to overheating, they must be inspected every month. Replacing filters is an inexpensive component of an effective UPS maintenance plan.

Power supplies. Although a UPS may have redundant power supplies, it is possible for the power supply to suffer from input voltage surges, which can cause unexpected stress and overheating. Regular inspection is recommended to detect potential issues.

Contactors. Because they may collect fine dust and other resistive coatings, contactors should be inspected and cleaned to prevent premature failures.

Sticking or welded relays. These may go unnoticed until emergency change-of-state events happen. Periodic inspections can detect potential problems before they occur.

Surge suppression device (SPD) integrity. It is important to verify that metal oxide varistor (MOV) devices are functional and have not been compromised by excessive transients.

While the numerous components that comprise a UPS are clearly susceptible to failure, a preventive maintenance service plan ensures these parts are regularly examined, greatly reducing the risk of a load loss while extending the overall lifespan of your UPS.

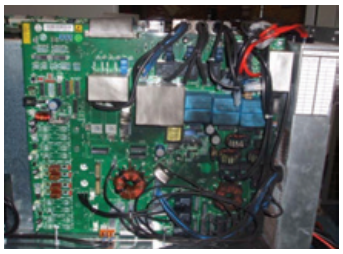

Photo 1. UPS failure due to the ingress of conductive, foreign material.

Photo 2. Random component failure.

What is your risk of UPS failure?

Because all manufacturers' UPSs are complex devices that perform several critical power conditioning and backup supply functions, they are all subject to failure (example above). However, by implementing a comprehensive preventive maintenance service plan delivered by trained and certified technicians, you can significantly reduce your vulnerability to a load loss and extend the lifespan of your UPS.

Analysis of millions of operating hours for thousands of UPSs has shown that mean time between failures (MTBF) for UPSs that receive preventive maintenance twice a year is more than 20 times better than for UPSs that receive no preventive maintenance. Increase the frequency of preventive maintenance to quarterly, even monthly, and UPS reliability and service life just keep getting better. Prevention pays off.

Customers who do not get that attention or do not have access to the original equipment manufacturer (OEM) service organization face significant threats. Based on Eaton service records, more than 25% of preventive maintenance visits result in follow-up service to perform corrective actions or upgrades. Therefore, proving proper maintenance allows threats to be identified and resolved proactively before putting the business at risk.

Enhance your return on investment

For many businesses, measuring the return on investment (ROI) of a preventive maintenance plan is simple, since a single downtime event can cost more than the entire expense of the UPS and service plan.

A common approach to evaluating the potential savings associated with implementing a preventive maintenance plan is to calculate your cost of downtime. This evaluation should include direct and indirect costs, such as lost business opportunities, the cost of restoring servers, personnel downtime, and damaged reputation. In some applications, it should also include the potential impact on safety. Most mission-critical customers are able to calculate their downtime and missed opportunity costs due to a business interruption. Safeguarding against these risks is increasingly important, as insurers and risk managers are increasingly recognizing the severity of potential damages.

Click to access Eaton's Downtime Cost Calculator
or find on Eaton.com/UPSservices

In a recent study from the Ponemon Institute, titled "Cost of Data Center Outages," 41 data centers participated and it was calculated that the average downtime duration was 1.7 hours, with an average cost per event of $505,502 or $4,911 per minute.

Eaton's Downtime Cost Calculator estimates your costs related to loss of sales revenues, loss of employee productivity, mission-critical data loss, and other intangible costs like the impact to your brand or service level agreement penalties. According to the Downtime Cost Calculator, the cost of downtime for a colocation data center that fits the following scenario would be $335,497.

Industry	Colocation
Annual revenue	$150,000,000
Number of employees	400
Average revenue per employee per year	$375,000
Days worked per employee per year	240
Hours worked per employee per day	8
Total hours worked per employee per year	1,920
Average revenue per employee / hour	$195
% of employees affected by downtime	100%
Square footage of data center or system*	10,000
Total hours data center or system is down*	2
Downtime costs	
Direct costs*	57%
Lost sales revenue	$34,247
Lost employee productivity	$156,250
Indirect costs*	43%
System restoration cost (additional labor)	$25,000
Reputation / brand impact	$30,000
Service level agreement impact	$50,000
Mission-critical data loss	$40,000
Total cost of downtime	
Per event*	$335,497
Per hour	$167,749
Per minute	$2,796
Per square foot of data center or system	$34

*Based off of "Calculating the Cost of Data Center Outages" Ponemon Institute, February 2011

When measuring ROI, the challenge is to maximize protection while minimizing cost. An effective preventive maintenance plan will help you accomplish both.

Typical maintenance replacement cycles and common UPS tests

Every UPS contains high-wear consumable components that must be replaced according to the manufacturer's specifications.

The following guidelines will help you determine the optimal replacement period for various UPS components:

Batteries:	
Standby use:	Inspect semi-annually; replace every 3 to 5 years for VRLA batteries Wet cell battery life is variable
Cycle use:	1200 cycles at 30% of discharge 550 cycles at 50% of discharge 250 cycles at 100% of discharge
Capacitors:	Inspect annually; replace every 5 to 7 years
Fans:	Verify annually, replace every 7 years
Air filters:	Inspect monthly; replace as needed
Lug terminals:	Any mechanical power lugs, annual visual and thermal inspection

Within an effective maintenance strategy are a number of functional tests and component checks that should be conducted regularly. Specifically, an operational test or major preventive maintenance event, which cycles the UPS through its various change-of-state modes, should be conducted while monitoring key operating parameters such as voltage, frequency, current and temperature.

The following operational tests are typical:

1. **Transfer to bypass and return to UPS** This test checks the static switch and bypass breaker motor operator or contactor. The test interval should be at least annually and it can be performed with the load on maintenance bypass.
2. **Battery operation and return** Sometimes coupled with a transfer-to-generator support and return to normal, this test is typically performed monthly and tests the UPS, generator, and automatic transfer switch (ATS) functions.
3. **Load balancing evaluation** This test checks for loads on any phase that may be approaching 100 percent. To limit potential overloads, loads may be redistributed as necessary. It is important to note that any one phase may be overloaded and trigger an unexpected alarm or transfer, even if the other two phases are only lightly loaded.
4. **Phase rotation/site wiring checks** This test inspects for out-of-limit bypass alarms or site wiring faults that may have occurred as a result of normal site wiring changes or maintenance. These problems can go undetected until a transfer to bypass is attempted.
5. **Listening tests** An experienced technician should listen for abnormal operational sounds, particularly arcing, fan-bearing noise, or synchronization problems, including hunting sounds or beat frequencies. These subtle hints can easily go unnoticed by users unfamiliar with the warning sounds.
6. **Operator refresher training** Since most power interruptions are a result of human error, constant attention should be paid to ensuring and documenting that all personnel with access to the UPS and associated switchgear have a solid understanding of the operation of the system and the consequences of any incorrect actions.

A maintenance strategy should also include an understanding of where an organization is headed, as well as its priorities for continuous operations. For example, are systems lightly loaded? Is the business experiencing unusual growth? How resilient must your operation be, and what do you consider a fast response: next day, the same day or in two hours? Once you have assessed your basic needs, you can prioritize which equipment requires maintenance agreements and what level of service is appropriate.

In addition to preventive maintenance, an effective UPS service plan should also include these 10 elements:

1. **Comprehensive battery services**
2. **A large team of skilled field technicians**
3. **Access to the technician of your choice**
4. **A defined escalation procedure**
5. **A proven commitment to safety, OSHA standards**
6. **An emphasis on long-term solutions, not short-term fixes**
7. **Prompt access to parts**
8. **Remote UPS and battery monitoring services**
9. **Multi-vendor services**
10. **Field upgrades and product modifications**

Conclusion

Every UPS contains high-wear consumable components that must be replaced according to the manufacturer's specifications. To ensure these parts are properly cared for and replaced when needed, regular maintenance is critical.

An effective preventive maintenance strategy can be one of the most cost-effective measures you can take to ensure the ongoing health of both your critical equipment and overall business. Because regular maintenance practices so dramatically improve UPS reliability and performance, while notably deterring downtime, preventive maintenance is an essential component of an end-to-end solution to keep your critical networks operating at peak performance in the face of multiple threats.

About Eaton

Eaton's electrical business is a global leader with expertise in power distribution and circuit protection; backup power protection; control and automation; lighting and security; structural solutions and wiring devices; solutions for harsh and hazardous environments; and engineering services. Eaton is positioned through its global solutions to answer today's most critical electrical power management challenges.

Eaton is a power management company with 2014 sales of $22.6 billion. Eaton provides energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. Eaton has approximately 102,000 employees and sells products to customers in more than 175 countries. For more information, visit Eaton.com.

About the author

Arthur Mulligan is a Raleigh-based product manager for Eaton's U.S. power quality service organization and has celebrated more than 14 years with Eaton. He has a varied background of marketing, advertising and sales experience in telecom, software and professional services. Prior accomplishments include expanding Eaton's' remote monitoring services (eNotify), developing a new online services configurator and redesigning service offerings between bundled packages and an a la carte (Flex) menu-based approach to drive customer value. Mulligan has a B.A. in economics and management from Albion College.

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