Effect of UPS on System Availability

White Paper 24

Revision 3

by Neil Rasmussen

> Executive summary

This white paper explains how system availability and uptime are affected by AC power outages and provides quantitative data regarding uptime in real-world environments, including the effect of UPS on uptime.

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Introduction

This white paper explains how system availability and uptime are affected by AC power outages and provides quantitative data regarding uptime in real-world environments, including the effect of UPS on up time. The data includes the effects of power outage frequency and duration, the restart behavior of the equipment, and factors related to the reliability of the UPS. The benefit of extended UPS run time on system reliability is also shown.

The uptime requirements placed on IS systems are increasing and targets of 99.999% (5-nines) reliability are often a stated target. Of the many factors that limit the ability of a system to achieve this level of performance, the AC power reliability is a very real barrier to achieving this objective. However, the relationship between ac power reliability and uptime is not obvious, and this is compounded by the fact that ac power reliability is often highly variable from site to site.

The AC power environment

The amount of standardized data on AC power reliability is quite limited. However, there are two significant surveys related to AC power reliability in the USA, which have been done, one by ATT Bell Labs and one by IBM. In addition Schneider Electric has some experience by having over 10 million UPS systems installed, many of which are capable of logging power problems.

AC power problems fall into three general categories, which are:

1. Outages or undervoltage conditions which cause the load equipment to cease function temporarily
2. Transients which cause load equipment to hang or otherwise malfunction temporarily and
3. Transients that damage load equipment

This document is restricted to analyzing the effects of ac power problems of category A, namely outages or undervoltage conditions. Therefore, you should assume that either 1) The equipment is properly protected by the transient protection of a surge suppressor or UPS, or 2) Real world downtime due to ac power problems will be larger than described in this paper.

In the USA, the data from surveys agrees with the experience of Schneider Electric and shows the following essential points:

1. The average number of outages sufficient to cause IT system malfunction per year at a typical site is approximately 15.
2. 90% of the outages are less than 5 minutes in duration.
3. 99% of the outages are less than 1 hour in duration.
4. Total cumulative outage duration is approximately 100 minutes per year.

This information is highly variable from site to site and in some geographic locations in the USA such as Florida (with frequent lightning activity) the outage rate is an order of magnitude higher. Building specific problems can also raise the outage rate by as much as 3 orders of magnitude. This data is also believed to be representative of Japan and Western Europe. This information indicates that the up time of AC power in the USA is approximately 99.980% uptime corresponding to 100 minutes of downtime per year. This is a very real barrier to achieving 99.999% up time corresponding to 4.8 minutes of downtime per year.

Effect of equipment behavior on uptime

The way the equipment responds to an outage can greatly increase the amount of downtime experienced in the real world. Equipment generally falls into three categories of response to ac outage:

1. Instant restart on power return
2. Auto restart after delay
3. Manual restart (human intervention)

Furthermore, in the case of manual restart there is a delay based on the service level of the staff on the equipment. This service level generally falls into the following three categories:

1. Staffed; 1 hour response
2. On call; 4 hour response
3. Remote; 24 hour response

When these factors are included, downtime due to ac power problems can degrade significantly as shown in the following table

Table 1

Effect of equipment behavior on system downtime: raw AC power

	Staffed	On-call	Remote
Instant restart	113 min	113 min	113 min
Auto restart- 5 minutes	189 min	189 min	189 min
Manual restart	1085 min	3812 min	21992 min

Effect of UPS on system downtime

When a UPS is added, three additional situations are created that affect downtime; these are:

1. Outages shorter than the UPS run time are eliminated
2. Outages longer than the UPS run time are delayed
3. The UPS itself can fail and create an outage

The clear benefit of the UPS is the elimination of outage events. The number of outage events is decreased when a UPS is installed independent of the behavior of the equipment or the service level as shown in the following table (PA= N+1 fault tolerant UPS such as APC Symmetra Power Array):

Table 2

Effect of UPS system on number of outage events

	Raw AC	5 min UPS	1 hr UPS	UPS with generator	PA with generator
Instant restart	15	1	.15	0.01	0.001
Auto restart – 5 minutes	15	1	.15	0.01	0.001
Manual restart	15	1	.15	0.01	0.001

When all factors are accounted for there is a significant reduction in downtime when a UPS is added, however the benefit is greatly affected by the service level provided to the equipment and the behavior of the equipment. This is shown in the following 3 tables:

Table 3

Effect of UPS system on system downtime: staffed service level

	Raw AC	5 min UPS	1 hr UPS	UPS with generator	PA with generator
Instant restart	113 min	100 min	10 min	1 min	0.1 min
Auto restart – 5 minutes	189 min	109 min	10 min	1 min	0.1 min
Manual restart	1085 min	208 min	20 min	1 min	0.1 min

Table 4

Effect of UPS system on system downtime: on-call service level

	Raw AC	5 min UPS	1 hr UPS	UPS with generator	PA with generator
Instant restart	113 min	101 min	11 min	2 min	0.2 min
Auto restart – 5 minutes	189 min	110 min	12 min	2 min	0.2 min
Manual restart	3812 min	509 min	51 min	5 min	0.5 min

Table 5

Effect of UPS system on system downtime: remote service level

	Raw AC	5 min UPS	1 hr UPS	UPS with generator	PA with generator
Instant restart	113 min	114 min	23 min	14 min	1.4 min
Auto restart – 5 minutes	189 min	122 min	24 min	14 min	1.4 min
Manual restart	21992 min	2513 min	255 min	29 min	2.9 min

Guidelines for UPS selection

From the above data, a variety of general conclusions can be drawn about selecting a UPS to reduce downtime.

1. A UPS can decrease *downtime* slightly or by 3 orders of magnitude depending on the choice of the UPS, the equipment behavior, and the service level.
2. Downtime performance is generally improved by an order of magnitude by increasing the run time of the UPS from 5 minutes to 1 hour.
3. Achieving 99.999% uptime requires a UPS with a run time of greater than 1 hour or a generator.
4. In remote sites both a fault tolerant (N+1) UPS and a generator are required to achieve 99.999% uptime.

5. Systems requiring manual intervention on restart exhibit the largest uptime increase benefits upon UPS installation.

Conclusion

Power outages are a significant barrier to achieving 99.999% uptime (4.8 minutes per year down). Remote sites where systems require manual intervention miss the 5-nines level by having downtime a factor of 4000 over the target. Typical corporate IT installations have a downtime 23 times the 5-nines target value. UPS can significantly improve uptime performance but long run times or generators may be required to reach the five-nines level of performance.

This paper does not include the effects on uptime of ac disturbances other than outages; overvoltage and transient problems create additional downtime that affect system performance and require mitigation. The use of a UPS eliminates these problems and therefore provides additional benefits besides those described here.

About the author

Neil Rasmussen is a Senior VP of Innovation for Schneider Electric. He establishes the technology direction for the world's largest R&D budget devoted to power, cooling, and rack infrastructure for critical networks.

Neil holds 19 patents related to high-efficiency and high-density data center power and cooling infrastructure, and has published over 50 white papers related to power and cooling systems, many published in more than 10 languages, most recently with a focus on the improvement of energy efficiency. He is an internationally recognized keynote speaker on the subject of high-efficiency data centers. Neil is currently working to advance the science of high-efficiency, high-density, scalable data center infrastructure solutions and is a principal architect of the APC InfraStruXure system.

Prior to founding APC in 1981, Neil received his bachelors and masters degrees from MIT in electrical engineering, where he did his thesis on the analysis of a 200MW power supply for a tokamak fusion reactor. From 1979 to 1981 he worked at MIT Lincoln Laboratories on flywheel energy storage systems and solar electric power systems.

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1. Allen and Segall, *Monitoring of Computer Installations for Power Line Disturbances*, IBM, IEEE PES Winter conference, 1974.

   (A study conducted from 1969 to 1970 using 38 monitor-months of data)
2. Goldstein and Speranza, *The Quality of US Commercial AC Power*, ATT Bell Labs, Intellec conference, 1982

   (A study conducted from 1977 to 1979 at 24 sites around the US)
3. Martzloff, *Power Quality Site Surveys: Facts, Fiction, and Fallacies*, IEEE Transactions on Industry Applications, Vol 24, No 6

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Data Center Science Center
DCSC@Schneider-Electric.com

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