Questions about Standby Power

Our team of sales engineers (who can be contacted every day during UK business hours), will be pleased to answer your enquiry. However, you may find the following FAQs valuable.

FAQs

Q: *"What can a UPS do for me?"*

A: Every UPS will supply power to a load (such as a computer, telephone switch or medical equipment) when mains power fails. It may also condition the power and prevent spikes, brownouts, interference and other unwanted problems from reaching the supported equipment.

^ Hide this answer ^

Q: *"How long can a UPS keep my equipment running for?"*

A: As long as you want, providing you buy enough batteries and the charging system is up to it. After about four hours it's usually more cost-effective to buy a generator, with a short runtime UPS to bridge the generator start-up gap.

^ Hide this answer ^

Q: *"How does a UPS work?"*

A: Please see 'Understanding UPS'

^ Hide this answer ^

Q: *"What's the lifetime of a UPS?"*

A: Most plug-in UPS are good for at least five years. We'd advise you to change the batteries every three to four years. With larger equipment (and more substantial investment), the lifetime of the equipment increases. We maintain equipment that's twenty years old and still going strong.

^ Hide this answer ^

Q: *"How do UPS work with generators?"*

A: A well-maintained generator will start within around twenty seconds of mains failure. Many modern electronic products are computer-based and will 'crash', usually requiring a back-up to be reloaded before work can restart. A UPS bridges the gap between mains failure and generator start-up

^ Hide this answer ^

Q: *"Is a generator and UPS the ultimate solution?"*

A: No, it's a good solution if you're prepared to either close down your data centre or take a risk when it come to maintenance time. Both a generator and a UPS have to be taken off-line for maintenance. A solution for a 24/7 data centre must include redundant UPS and generators to allow maintenance to be carried out whilst remaining protected. An additional benefit is that in the unlikely event of failure of a unit the spare unit(s) will take up the load.

^ Hide this answer ^

Q: *"My office is unmanned at night. How will I know if the power has failed?"*

A: Many UPS can be fitted with an auto-dialler which will call you in the event of power loss. Equally, we can send emails or SNMP messages anywhere in the world, flash lights, sound alarms and generally find you anywhere you want to be located.

^ Hide this answer ^

Q: *"Will my UPS protect my equipment from a lightning strike?"*

A: It's not designed to, but depending upon the proximity of the strike and the quality of the unit it may well do so. Much damage to IT equipment comes from strikes on telephone lines. Some small UPS have comms line surge suppressors as an accessory, and these will also help. Lightning strike protection should properly be treated separately to UPS support. Our engineers can help you with that.

^ Hide this answer ^

Q: *"What's three-phase electricity?"*

A: Electricity is delivered around Europe as three-phases. Between any phase and neutral we get roughly 230 volts. Between any two phases we get about 415 volts. Large office

premises and industrial sites usually have all three phases supplied in order to run heavy equipment. We supply both single and three-phase systems.

^ Hide this answer ^

Q: *"We're on the fifteenth floor. We can't use the roof space, and there are no car parking spaces we can use. How can we get extended runtimes for our equipment?"*

We have super-silenced generators that can be fitted in your office with just an exhaust pipe out of the window, or in some instances we can use Fuel Cell systems which are completely silent and need no external exhaust.

01.01

Q: What is this document?

A: This is a FAQ document on Uninterruptible Power Supplies. It is intended to provide a starting point for those people that want to find out what they are, what they do, and what's available.

Note that most of this document is very US-centric. The power numbers, companies and services all emphasize US consumer needs. Sorry, but that's what I have to work with. All the principles discussed here should be applicable just about everywhere.

01.02

Q: How is this document made available?

A: Currently, this document is available on the World Wide Web. It is referenced with most major search engines. Many sites link to this document or reference it.

This document itself is available via the World Wide Web at:
`http://www.jetcafe.org/~npc/doc/ups-faq.html`.

01.03

Q: Who maintains this?

A: Right now, this document is maintained by Nick Christenson. My preferred email address is npc_AT_jetcafe.org, and I would like it very much if questions regarding this document could have the word "UPS" or "UPS FAQ" or some such in the Subject line. Note: I am maintaining this on my own time, so please don't be upset if it takes a while for me to respond to your queries. Also none of the information in here represents the views or has the blessing of any organization whatsoever. This represents one person's opinions, although many have contributed useful material to this document and my understanding.

01.04

Q: Where did this information come from?

A: Thankfully, many people have rallied to my cry to fill in the many gaps in my original draft. This is now a group work, although I claim full responsibility for misstatements and inaccuracies.

01.05

Q: How can I contribute?

A: You should mail new information, corrections, suggestions, etc. to the current maintainer of this FAQ. If you provide a suggestion, make sure you reference where the information is located in the document. I guarantee that suggestions of the form "Change the word 'always' to 'almost always' in the part about surge suppression." will be ignored.

01.06

Q: Are there any restrictions on distribution of this document?

A: This document is copyright by the author. You are encouraged to distribute this document for any non-commercial purpose as long as the contents remain unaltered, the original document and author are properly cited, and a pointer to an up-to-date version is included. If you would like to excerpt this document, that's okay too, as long as proper attribution is given and a pointer to the complete FAQ is included.

01.07

Q: Got anything else you'd like to add?

A: Yes, now that you mention it. The people who contribute to this document can speak only about equipment they have experience with. This may reflect a bias toward or

against certain brands, features, functions, etc.. Please keep in mind that the suggestions, brand names and functions here are by no means exhaustive, or even necessarily applicable to your situation. Also, if you have information that is not in this document, please submit it to the maintainer listed above. If you submit information, please say whether you'd like it to be attributed to you or not. I am more than glad to give credit to the fine people who helped with this document, but I want to respect the anonymity of those people who would prefer it.

01.08

Q: Glossary

A: This was contributed almost entirely by some kind soul. I just cleaned it up a bit.

Blackout
: Complete loss of power. Some literature considers a voltage drop below about 80V to be a blackout as well since most equipment will not operate below these levels.

Sag or Brownout
: Decrease in voltage levels which can last for periods ranging from fractions of a second to hours. Can be caused by heavy equipment coming on line such as shop tools, elevators, compressors etc. Also occurs when utility companies deliberately do this to cope with peak load times.

Spike
: An tremendous increase in voltage over a very short period of time often caused by a direct lightning strike on a power line or when power returns after a blackout.

Surge
: An substantial increase in voltage lasting a small fraction of a second, often caused when high powered appliances such as air conditioners are switched off.

EMI/RFI Noise
: ElectroMagnetic Interference and Radio Frequency Interference. Caused by, inter alia, lightning, generators, radio transmitters, industrial equipment.

MOV
: Metal Oxide Varistors are added to circuits in order to control spikes. These are common in Power Strips. If you see more than two, you likely have a fairly decent Power Strip. They look like largish disk capacitors.

Inverter
: Circuitry that converts DC battery power to AC power required by most computer equipment.

Surge Protector
: Circuitry consisting of MOVs, capacitors, rod-core inductors etc. for suppressing surges and spikes usually embedded in a power strip.

Line Conditioner
: A transformer that attempts to smooth out fluctuations in input voltage to provide near uniform output voltage or voltage waveform.

02:
TOPIC: What is a UPS and how does is work?

02.01

Q: What is a UPS?

A: An Uninterruptible Power Supply is a device that sits between a power supply (e.g. a wall outlet) and a device (e.g. a computer) to prevent undesired features of the power source (outages, sags, surges, bad harmonics, etc.) from the supply from adversely affecting the performance of the device.

02.02

Q: How do you pronounce "UPS"?

A: Many pronounce it "ups", but most of the literature seems to favor "you pee ess", since they use "a UPS" instead of "an UPS". This document will try to follow the literature. Neither pronunciation will get you laughed at by those who are experienced in the field.

02.03

Q: Vendor X says that (fill in description) is a UPS, but it's different than what you describe above. Who's right?

A: There really is no standard definition of what a UPS is. Anything ranging from a 9 volt battery backup in a clock radio to a building/compound wide backup generator has been called a UPS by someone. The majority of this document refers to objects larger than a beer can that help devices remain temporarily operational when changes to the power they receive would otherwise interrupt their function.

Maintaining power to a minicomputer (like a VAX 11) is beyond the scope of this document. This FAQ deals with UPS equipment that can be installed by a computer owner/administrator. If you have requirements that large, you need to talk to a qualified electrician. Basically, the focus of this document is on power protection devices that operate in the 3000 Volt-Amp (VA) range or lower. These are smaller machines that can be installed and managed without the assistance of licensed electricians.

02.04

Q: Can you give me some more information on the UPS industry?

A: (Kindly provided by Don Deal, `Don.Deal_AT_oit.gatech.edu`, my additions are in [square brackets].)

The UPS industry is made up of many manufacturers, and there is a lack of standard terms within the industry. I think this sometimes borders on deliberate misdirection. (It's a jungle out there!) [Note, in recent years the whole industry seems to have gotten better, at least mostly agreeing on what the terms listed here mean. This is not true everywhere, but things are getting better.]

There are basically three different types of devices, all of which are occasionally passed off as UPSes.

1. Standby power supply (SPS). In this type of supply, power is usually derived directly from the power line, until power fails. After power failure, a battery powered inverter turns on to continue supplying power. Batteries are charged, as necessary, when line power is available. This type of supply is sometimes called an "offline" UPS.

   The quality and effectiveness of this class of devices varies considerably; however, they are generally quite a bit cheaper than "true" UPSes. The time required for the inverter to come on line, typically called the switchover time, varies by unit. While some computers may be able to tolerate long switchover times, your mileage may vary. [Some articles in the trade press have claimed that their testing shows that modern PCs can withstand transfer times of 100ms or more. Most UPS units claim a transfer time to battery of about 4ms. Note that even if a computer can stay up for 100ms, it doesn't mean that 100ms switchover is okay. Damage can still be done to a computer or data on it even if it stays up.]

   Other features to look for in this class of supplies is line filtering and/or other line conditioners. Since appliances connected to the supply are basically connected directly from the power line, SPSes provide relatively poor protection from line noise, frequency variations, line spikes, and brownouts.

   [Some SPSes claim to have surge/spike suppression circuitry as well as transformers to "boost" voltage without switching to the battery if a modest voltage drop occurs. Often, as a "standby" UPS becomes more featureful it is called a "line interactive" UPS.

2. Hybrid [or ferroresonant] UPS systems. I only know one vendor who sells them - Best Power, Inc. [Now called Eaton Powerware. Note that Powerware also sells line interactive and online UPSes.] The theory behind these devices is fairly simple. When normal operating line power is present, the supply conditions power using a ferroresonant transformer. This transformer maintains a constant output voltage even with a varying input voltage and provides good protection against line noise. The transformer also maintains output on its secondary briefly when a total outage occurs. Best claims that their inverter then goes on line so quickly that it is operating without any interruption in power. Other UPS vendors maintain that the transition is less than seamless, but then again it's not in their best interest to promote Best's products.

[Note: According to some sources, ferroresonant transformers in an UPS system can interact with ferroresonant transformers in your equipment's power supply and produce unexpected results. On the other hand, ferroresonant UPS systems don't kick off a lot of heat, which is important in some environments. The Moral: Test equipment to make sure it meets your needs before you buy. -npc]

3. What I call "true" UPS systems, those supplies that continuously operate from an inverter. Obviously, there is no switchover time, and these supplies generally provide the best isolation from power line problems. The disadvantages to these devices are increased cost, increased power consumption, and increased heat generation. Despite the fact that the inverter in a "true" UPS is always on, the reliability of such units does not seem to be affected. In fact, we have seen more failures in cheaper SPS units. [Note, though, that given the same quality inverter, you'd expect the one that runs least to last longest. These devices are often called "online" UPSes.]

02.05

Q: How can it help me?

A: A UPS has internal batteries to guarantee that continuous power is provided to the equipment even if the power source stops providing power. Of course the UPS can only provide power for a while, typically a few minutes, but that is often enough to ride out power company glitches or short outages. Even if the outage is longer than the battery lifetime of the UPS, this provides the opportunity to execute an orderly shutdown of the equipment. Advantages:

1. Computer jobs don't stop because the power fails.
2. Users not inconvenienced by computer shutting down.
3. Equipment does not incur the stress of another (hard) power cycle.
4. Data isn't lost because a machine shut down without doing a "sync" or equivalent to flush cached or real time data.

02.06

Q: What sort of stuff does a UPS do?

A: A UPS traditionally can perform the following functions:

1. Absorb relatively small power surges.
2. Smooth out noisy power sources.
3. Continue to provide power to equipment during line sags.
4. Provide power for some time after a blackout has occurred.

In addition, some UPS or UPS/software combinations provide the following functions:

1. Automatic shutdown of equipment during long power outages.
2. Monitoring and logging of the status of the power supply.
3. Display the Voltage/Current draw of the equipment.
4. Restart equipment after a long power outage.
5. Display the voltage currently on the line.
6. Provide alarms on certain error conditions.
7. Provide short circuit protection.

02.07

Q: How long can equipment on a UPS keep running after the power goes?

A: That depends on how big a UPS do you have and what kind of equipment it protects. For most typical computer workstations, one might have a UPS that was rated to keep the machine alive through a 15 minute power loss. If it is important for a machine to survive hours without power, one should probably look at a more robust power backup solution that includes a generator and other components. Even if a UPS powers a very small load, it must still operate its DC (battery) to AC converter (the inverter), which costs power. A rough extrapolation from APC's documentation, leads me to guess that its 2000 VA UPS can operate its own inverter (with no extra load) for just over 8 hours. A 1250 VA UPS could run its converter for about 5. These are *very* rough guesses based on information provided by one vendor for one vendor.

02.08

Q: Given the same vendor claims, how can I tell a "good" quality UPS from a "poor" quality UPS?

A: Testing, testing, testing. I can't emphasize this enough. There are many good and bad units out there that call themselves UPSes. There are many good units that are wrong for your situation. Caveat Emptor.

Some properties you might look for include:

1. Sinusoidal power output. In general, the closer the AC output of the UPS is to a sine wave, the better it is for your equipment. Many UPS units, especially the cheaper ones, deviate a great deal from a sinusoidal output. Some of them generate square waves. Waveform effects are dealt with in section 2.12 of this document.
2. Does the UPS have a manual bypass switch? If the UPS is broken or is being serviced, can you pass power through it to your equipment? The last thing you want is for a broken UPS to be the cause of extra downtime.
3. The more information about a UPSes operation you can get from watching the unit itself, the better. How much power (or percentage load) the equipment is drawing, how much battery life is left and indications of the input power quality are all very useful.

4. Some newer UPSes can communicate with their monitoring software via a network connection and SNMP. This is wonderful *if* your network is on a UPS. Also, beware, I have heard of dealers advertising "Network UPS" monitoring where the network is the normal serial connection.
5. Does the UPS vendor offer support/maintenance contracts? If they aren't offered, I would suspect the quality of the equipment.

If you do have a UPS that does not output a sinusoidal waveform, some manufacturers *strongly* urge you to not put a surge protector between the UPS and the computer. The surge protector might mistake the non-sine waveform as a power surge and try to send it to ground. This could be bad for your UPS, not to mention your equipment. I don't know if this has happened or not, but I wouldn't chance it.

02.09

Q: Should I make sure I have a support/maintenance contract for my UPS systems?

A: Some people strongly recommend this, some don't. It depends on the situation. There are things that can go wrong with UPSes, and they require periodic maintenance. As with all support contracts, you're generally spending a little extra money to reduce risk. Whether this is worthwhile is up to you.

While the electronics in a UPS are likely to last for quite a while, the batteries will periodically need to be replaced. This will happen more frequently the more (and deeper) the batteries are cycled. Replacing the batteries every three years is a pretty typical vendor recommendation (but read the product details for authoritative information). Any UPS battery that has been in continuous service for five years probably should be considered suspect until proven otherwise.

Like any other electronic device, a UPS can fail. You need to have a plan for this. If you don't want to risk having to replace a failed unit at an inconvenient time, you might want to look into a support contract.

02.10

Q: What sort of maintenance can I perform myself?

A: One good thing you might want to do is periodically test the UPSes and their failure modes. A good time to do this might be right after after a periodic level 0 backup. Nobody is logged in and you've got full backups of the machines. Throw the circuit breaker with the UPS on it to simulate and outage and see how the transition goes. Note that in general testing an UPS by pulling the plug from the wall is *not* a good idea. Electronics like to always have a good ground reference. If you unplug a UPS, it's still powered but now has what electricians call a "floating ground". Not only can this be bad for electronics, but it can be quite dangerous as well. It is likely that unplugging just about any UPS for a short amount of time isn't likely to result in disaster (don't take my

word for it, though!), but in all cases, throwing a circuit breaker would be a better thing to do.

It might be useful to install a GFI (Ground Fault Interrupter) on your UPS-covered outlets to facilitate this testing without having to throw a breaker, especially if you don't have your UPS protected machines on an isolated circuit (which you probably should). These are the sockets found in most modern kitchens and bathrooms with a red and a black button. You push the latter to cut power and the former to restore power.

Almost all UPSes use lead-acid batteries, like most car batteries. Unlike, say, NiCad (Nickel-Cadmium) batteries, lead-acid batteries do not have "battery memory". Each "deep cycle" (running the batteries to very low or even drained levels) will decrease a lead-acid battery's effectiveness, so this should be avoided. Of course, handling these situations is the reason you've bought a UPS, but one should not run a UPS down when doing so isn't necessary.

As a UPS gets older, its battery life will become shorter. Of course there's no way to reliably test how long it is without running the battery down and you don't want to do that because they have lead acid batteries. <sigh> All of these are very good reasons to get a support contract for them that includes periodic battery replacement. At the very least, you can figure that under a normal workload the batteries will usually still be reasonably good at the end of the UPS warranty figure, so that's a good place to start guesswork.

02.11

Q: Isn't a UPS just a glorified power strip/surge protector with some batteries and a little power conditioning thrown in?

A: Basically. It's also got a power inverter and some other circuitry. It may also have a timer, thermometer or other gadgets.

02.12

Q: How important is the UPS output waveform?

A: That's a good question, and one is worthy of some debate. One school of thought holds that one should always run equipment on the best approximation of sinusoidal input that one can, and that deviations produce harmonics which may either be interpreted as signal if they get through a power supply, or may actually damage the equipment. Another school holds that since almost all computers use switching-type power supplies, which only draw power at or near the peaks of the waveforms, the shape of the input power waveform is not important. Who's right? I don't know. My *opinion* is that sinusoidal output is worth the extra money, especially for on-line UPS systems that continually provide their waveform to the computer. Also, if you don't *know* that your equipment has a switching-type power supply, you might want to think twice before

buying a low quality UPS. [Some of this information from a great article in the October 1994 issue of LAN Magazine, check it out. -npc]

02.13

Q: Can I really count on a UPS protecting my equipment?

A: This is a tough question. While most UPS systems that you're likely to buy in a store or computer catalog are likely to help your uptime more than hurt it, these are *not* intended for safety or life-critical equipment.

Basically, these devices should be considered to be pieces of consumer electronics. The number one basis on which most of these devices compete with each other is on price, not quality. I have had UPSes arrive dead from the factory. I have had them fail (taking equipment down with them) within weeks of first installation. I can't prove it, but I'm willing to bet that when an old (beyond warranty) line-interactive UPS from a major manufacturer died on me it fried a machine motherboard, memory, network card, and monitor. In the < 2000 VA range, cost-effectiveness is more important to UPS vendors (because it appears to be more important to their customers) than ultimate reliability. If your life depends on computer uptime, you need a special purpose, online, big, redundant, expensive system. These systems are beyond the scope of this document. When you buy a UPS at your local computer store, you are *not* buying this sort of system.

This is not to say that these things are bad or a waste of money, it's just that they're not a panacea. In most locations I have worked with most decent UPSes my equipment statistically has suffered less downtime and lower hardware failure rates when it's protected by a UPS than when it's not. But these devices are *not* infallible. When you add one to the mix, technically it's one more thing that can and sometimes will go wrong. These devices age and occasionally break. A bad one occasionally slips through quality control. Consider it two steps forward and one step back. That's still progress.

There are some things you can do to decrease the likelihood that a UPS will trip you up. Here are some suggestions. This is not an exhaustive list:

- Perform regular maintenance on your UPS. This includes changing the batteries periodically. Don't ever run on bad batteries. Unless your UPS has a bypass feature which allows you to change batteries without disconnecting the UPS, this means shutting your important server down on occasion.
- Don't deep cycle the batteries any more than is necessary.
- Make sure the UPS keeps in contact with its electrical ground at all times.
- Don't subject the UPS to temperature or humidity extremes, water, excessive dust, or excessive static electricity. Keep the area around the UPS clean and dry.
- Don't overload the UPS.
- If the UPS shows signs of misbehavior or malfunction, remove it from service at the earliest possible opportunity. Don't put it back into service until it has been examined and recertified by qualified support personnel.

02.14

Q: I think I'd like to build/refurbish/upgrade my own UPS myself. Is this a good idea?

A: My short answer: No, it's not a good idea. Basically, if you're soliciting information from this document on whether or how to do this, you're not qualified to do this, so don't.

Just as with any other electronics project, it's possible to build one yourself if you know what you're doing. In the case of a UPS, though, the tolerances are very tight, and the consequences of building it wrong can be severe. You're working with energies sufficient to kill a person or start a major fire, the batteries contain hazardous materials, and the serious possibility exists that something can be hooked up wrong with disastrous results. If the wrong types of batteries are installed in a UPS very bad things will happen. Unless you really know what you're doing, you're much better off sticking with equipment that others have certified rather than trying to save just a few bucks by doing it yourself. Of course, if you do really know what you're doing, then you don't need (or want) my advice. Definitely leave this project for the professionals.

03:
TOPIC: UPS monitoring/shutdown software.

03.01

Q: If the power is out for a long time, I would like to have my computer automatically shut itself down gracefully before the UPS batteries die. Can I do this?

A: Yes. Most UPS manufacturers support software that will do this for some UPSes on at least some platforms. Ask your UPS vendor for details.

Q: Okay, how about restarting the system for me once power returns?

A: Not all UPS software products do this, but many do. Again, ask your vendor. I do not know of any freely distributable products that will do this. It doesn't mean that they can't be built, but vendor software is cheap enough (usually) that it's probably not worth building.

03.02

Q: How does this software work? I'm a starving (fill in the blank) who can't afford software or I have a UPS protecting a computer running an operating system that nobody supports.

A: Usually, there is a serial port on the back of a UPS that can be used to connect it to just about any computer. Sometimes these connections are null-modem, sometimes they're not. The UPS sends information along the serial line as it goes. If you can decode

which pins contain which information, how the information is formatted and figure out what it wants to hear from the computer side, you're all set.

Here is a skeleton script that outlines a very simple UPS interface provided by Joe Moss, joe_AT_morton.rain.com. Definitely check this out as a starting point, but don't expect it to do anything meaningful without some work.

```
#! /bin/sh

# Shut down system in case of extended power failure

# This should be the serial port to which the UPS is connected
# This port must be set to block on open until the DCD line
# is asserted - many UNIX systems have this determined by
# the minor device number, if not, see if there is some way
# to enable this behavior on your system
PORT=/dev/ttya

# Ok, this should block until there is a power failure

: > $PORT

# If we reach this point, we've lost power
wall << EOF
The sky is falling!! The sky is falling!!
EOF

# call shutdown (or init or whatever)
exec shutdown
```

03.03

Q: Hmmm... that sounds kinda complicated. Has someone already done this?

A: Any solution would almost certainly be vendor specific. However, some brave souls have provided partial functionality for certain vendors' UPSes. The `upsd` and `upsmon` packages are Open Source software that supports APC UPSes. They are available at: ftp://ftp.rge.com/pub/admin/upsd/ and ftp://newcorridor.com/pub/upsmon/.

Note: Different UPSes produce different sorts of signals. Some software that works with one brand or model of UPSes may or may not work with others.

03.04

Q: I can't find monitoring software that will work on my configuration. What should I do?

A: Well, it seems you have a few choices:

1. Build your own. See item 03.02.

2. Use something freely distributable. See item 03.03.
3. Lean on your UPS vendor to port to your platform.
4. Try a different vendor that supports your platform. See item 05.01.

03.05

Q: What other software is out there?

A: Software packages for UPS machines are getting more sophisticated. Most provide some level of power and status monitoring, but lately there are more GUI's, more interactive packages, SNMP support, and even call-out paging. See the software section 05.03 for more info.

04:
TOPIC: How big a UPS do I need?

04.01

Q: How are the "sizes" of UPSes determined?

A: Typically, a UPS has a VA rating. The VA rating is the maximum number of Volts * Amps it can deliver. The VA rating is not the same as the power drain (in Watts) of the equipment. (This would be true if the load were only resistive or the circuit were DC, not AC). Computers are notoriously non-resistive. A typical PF (power factor: Watts/VA) for some computers may be as low as 0.6, which means that if you record a drain of 100 Watts, you need a power source with a VA rating of 167. Some literature suggests that 0.7 may be a good conversion factor, but this will depend heavily on the specific equipment. Moreover, there's really no way to determine these numbers besides measuring them.

Note: Some UPSes can continue to deliver power if the VA rating is exceeded, they merely can't provide above their VA rating if the power goes. Some can't provide power above their VA rating at all. Some may do something really nasty if you try. In any case, I *strongly* recommend not doing this under *any* circumstances. Generally, the rule of thumb seems to be never drawing more VA from an UPS than about 75% of its rating.

04.02

Q: How can I tell what VA rating I need for my equipment?

A: First, when possible, get VA rather than wattage ratings. See Q04.01 above. There are a couple of ways to evaluate your electrical load:

1. Direct measurement. You can get equipment to measure the current draw of your equipment directly. You may or may not have access to this. If you are part of an

organization that has its own facilities/electrical type people, they're likely to be able to do this. They might help you out if you ask nice. If you're on a budget and don't want to shell out for a high-quality ammeter, you might want to dry a device called the "Kill A Watt" electric usage monitor made by P3 International.

2. Compare notes. If you know someone with the same setup you're using, ask them what they use and how close they are to the maximum VA rating.
3. Use a chart. Most vendors can help you out for common equipment. If you have an unusual setup, or mix equipment a lot, this may be more difficult.
4. Use the equipment rating. Most pieces of computer equipment have a power rating on some back panel near where power cord enters the chassis. This number is usually very conservative, as it is necessary for the manufacturer to play it safe or they'll get sued. Also, these numbers generally represent a conservative estimate of total draw of the equipment when it is in its most power-hungry configuration. Typical device configurations may be less demanding.

Note: Method 1 is by far the best, method 2 and 3 are secondary, method 4 is usually overkill, but pretty safe. In a pinch, obtaining a UPS whose VA rating is equal or greater than the sum of all listed electrical load ratings is pretty safe. Don't forget to include headroom for expansion!

04.03

Q: Hmmm... seems like this can be a tough thing to determine.

A: Yeah, it can be. It's also very important. Remember, if you get a UPS that's too big, then you've overpaid, but your equipment can survive a longer outage. If you get a UPS that's too small, your equipment might not be protected. Therefore, I recommend that you be conservative in buying these things. Unfortunately, this costs money.

04.04

Q: What else should I consider?

A: It would be nice to know how long your site's typical power outages are. In some places, with nice weather and a flaky power grid, the power is almost never out for more than 5 minutes, but this could happen quite frequently. In this case, you may as well use a UPS with a VA rating close to your equipment rating with no extra batteries. If your area has longer outages, in the half hour or hour range, as is often the case in thunderstorm country, you can either buy UPSes with multiples of the VA rating of the equipment, since oversizing a VA rating for a UPS has the effect of lengthening the amount of time your equipment can stay up in case of a power outage, or you can buy additional battery units for a smaller UPS. You can probably get away with doing simple math to determine how much longer a larger UPS will keep your equipment running, but I recommend running a few tests before committing to a large purchase order. Also, your UPS vendor will almost certainly be glad to help you size the equipment you need. If all else fails and you guess wrong, or move equipment to a location with different power status, you may

be really, really glad if you bought a UPS that can be expanded with additional battery units.

04.05

Q: How about I use one of these UPS thingies for a laser printer?

A: Generally, this is not a good idea. If you ever measured the current draw of a laser printer during startup (and during printing) you'd likely be stunned at what it pulls. UPS manufacturers generally recommend that you not do this. Some UPSes are available that are specifically inteded for use with laser printers, but most don't. At the very least, don't do this unless you have carefully sized your equipment and your UPS vendor has committed to supporting this particular configuration.

04.06

Q: So, what sorts of UPS sizes do you use on your equipment?

A: BIG DISCLAIMER. I disclaim everything about these figures. At best, they are very, very rough. Heck, I may be lying. Don't trust them. Here they are anyway.

Most PC ATX power supplies these days seem to be running in the 300 W range. A typical CRT monitor tends to draw about 1 Amp (~120 W), an LCD monitor of the same size a bit less. Peripherals like speakers and small networking equipment tend to draw little power. Figuring on 450 VA for a typical desktop computer setup is pretty conservative. For a single machine plus small associated networking equipment (for example, a DSL/Cable modem/router, wireless access point, etc.), buying a 600 VA UPS is often pretty reasonable. Buying a bigger UPS will allow you to protect more equipment going forward.

Another word of warning, don't assume that power requirements scale with compute power and number of peripherals, ESPECIALLY if they are different architectures. Sometimes older equipment is less efficient and draws more power than more recent gear. This is espeically true with things like monitors, disks, etc.. On the other hand, as compute power increases, often power consumption does too. The current crop of Pentium 4s draws much more power than, say, an old 386 did. This can be seen in the fact that contemporary PC power supplies are usually more powerful than the same devices were a few years ago. The big lesson to learn is that there's no replacement for direct measurement.

05:
TOPIC: Specific manufacturer's information.

05.01

Q: What vendors are there and what do they produce?

A: Here is a very incomplete list, based only on what I know. Please give me information to expand it. I make no claims as to the accuracy of this information. It is mostly based on personal recommendations and vendor propaganda.

05.02 UPS Hardware (and software) manufacturers:

In earlier versions of this document, I gave contact information and a brief (usually a bit out of date) product listing of all the major UPS vendors I could find. Now, with nearly all of this information on line, it makes more sense just to provide a link to the web pages of the companies and list what sort of general market they're in. I think this is actually more useful and is certainly less likely to drift out of date. Note, I'm including information only on manufacturers, not retailers.

American Power Conversion	APC is the largest manufacturer of small UPSes (<2000 VA) and has a whole line of UPS systems (mostly line interactive), software, and power system accessories which can be purchased directly from them or via many retail outlets around the United States and overseas.
Belkin	Belkin makes a lot of computer connectivity products, including UPSes.
Clary Corporation	Clary sells UPS products and specializes in emergency, military, and life support systems. They also sell management software and accessories.
Controlled Power Company	Controlled Power produces UPS systems, power conditioners, voltage regulators and transformers. Equipment can be ordered direct.
Eaton Powerware	Eaton Powerware includes the product line that was formerly Best Power, Inc.. They produce many types of UPS systems. more advanced line interactive systems, and ferroresonant line interactive systems as well as software, PDUs, and power system accessories.
Emerson Electronics	Emerson is a big electronics conglomerate. It's claim to fame in the UPS world is that it's the parent company to Liebert.
Energy Technologies, Inc.	Energy Technologies provides power devices (including UPSes) for physically demanding customers, including military and vehicle uses. Most if their UPS systems seem to fall in the 600 to 6000 VA range.
Exide Electronics	One of the bigger players in the data center sized UPS system industry, Exide also makes more modest sized on-line and line interactive systems. Exide products can be purchased direct or from their distributors.

Gamatronic Electronic Industris, Ltd.	I'm told these guys are the largest UPS manufacturer in Israel and the Middle East. Their product line runs the gammut from 1000 VA to 150 kVA systems.
General Electric Industrial Systems	Yup, GE makes UPSes from 300 VA up to MVA systems.
IntelliPower, Inc.	Intellipower sells on-line UPS systems and management software.
Liebert	A subsidiary of Emerson Electronics (see above), Liebert is probably the largest manufacturer of large (10 kVA +) UPS systems. Also well known for their other data center products including power distribution units and HVAC products. They also make smaller UPS systems (300 VA on up), but these are not nearly as popular.
MGE UPS Systems	MGE UPS Systems sells UPS systems from 300 VA to the very large and additional power equipment.
Mitsubishi Electric Automation	Mitsubishi Electric Automation seems to specialize in larger (> 5 kVA) UPSes, but they make them as small as 1 kVA.
Oneac	Oneac sells line interactive and online UPS systems with software in the US and UK. They were acquired by the Chloride Group (see Chloride Power, below) in 1998.
OPTI-UPS	OPTI-UPS makes standby, line-interactive, and online UPS systems ranging from 375 VA to 8000 VA.
Philtek	Philtek makes inverters and other similar power system components.
SL Waber	SL Waber sells mostly UPS systems including the Tripp Lite brand name as well as a wide assortment of surge suppression and other power accessories.
Toshiba	Toshiba sells a lot of things, including UPSes. They sell online UPSes from 1400 VA to the 300 kVA range. One of Toshiba's product lines are UPSes specially designed to automatically configure themselves to work with both US (60 Hz) and European (50 Hz) power.
P3 International	P3 International makes a number of cool consumer electronics devices, but as far as this document is concerned, the most interesting is an easy-to-use and relatively inexpensive power monitoring device called "Kill A Watt". When you can't or don't want to use a good break-out cable and ammeter, this device is a good choice for measuring power consumption.
Power Innovations International, Inc.	Power Innovations sells online UPS systems ranging from 500 VA to 400 kVA.
Chloride Power	Chloride Power is a relative newcomer to the U.S. market but has much more experience and is better known in Europe.

For the US market Chloride produces online UPS from the 700 VA to 3000 kVA range, and what look like they might be standby systems from 300 VA to 650 VA.

There are a lot of companies in this space, and there's no way that I can list all of them. I try to include most of the best known companies along with a few niche players that might be of interest to the readers of this document. Let me know if there are important companies that I haven't included.

06:
TOPIC: Bibliography

There are many good references and review articles on UPS information. Some of the best sources can be found in vendor information. There is great reference material woven into their propaganda. Some other good sources are:

- "The Dranetz Field Handbook for Power Quality Analysis",
  1991, Dranetz Technologies, 1000 New Durham Rd., Edison, NJ 08818, 1-908-287-3680.
- "National Electrical Code Handbook",
  1993, National Fire Protection Association, One Batterymarch Park, P.O. Box 9101, Quincy, MA 02269, 1-617-770-3000.
- "Grounding and Shielding in Facilities",
  1990, by Ralph Morrison and Warren H. Lewis, John Wiley & Sons, New York, ISBN 0-471-83807-1.
- "Battling Power Problems",
  by Alan Frank, LAN Magazine, October 1994, pp 65-72, Miller Freeman, Inc..
- "UPS Chart",
  by the LAN staff, LAN Magazine, October 1994, pp 74-84, Miller Freeman, Inc..
- Hewlett-Packard has a White Paper on selecting a UPS. You may be able to get them to send it to you. A shortened version appeared as an article in the January 9, 1995 issue of Electronic Engineering Times.

One critical source of information on power protection is the IEEE "color book" series, especially the following:

- The Emerald Book, *IEEE Recommeded Practice for Powering and Grounding Electronic Equipment*, Std. 1100-1999, 1999.
- The Gold Book, *IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems*, Std. 493-1997, 1997.
- The Green Book, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems*, Std. 241-1990, 1990.

07:
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UPS Selector FAQ

Why does the UPS Selector indicate a lower power rating than the nameplate of my equipment?
Equipment nameplate ratings are never lower but often higher than the actual power drawn by electronic equipment. Nameplate ratings are required by regulatory agencies such as the EC or UL and are required to represent a power or current rating which the equipment will never exceed. As a result, manufacturers often are extremely conservative and place high nameplate ratings on equipment. It is not uncommon for the nameplate rating of computer equipment to be over two times the actual power draw. The UPS Selector power ratings are more accurate than nameplate ratings because they come from a database of actual power measurements for systems and configuration options.

Why does the UPS Selector suggest a longer run time than I have determined from past APC product literature?
There are three reasons why the UPS Selector indicates longer run time. First, past APC literature had less accurate information regarding equipment power draw and consistently overstated the power draw of load equipment. Second, many types of computer equipment consume less power than they did a few years ago so typical systems run

longer. Third, APC products of the same or similar model run longer than a few years ago because continuous improvements in battery technology are yielding batteries with greater energy output in the same case size. Run time tables for typical applications as provided in APC product literature and manuals are much less accurate than the values provided by the UPS Selector.

How does the UPS Selector work?
The UPS Selector determines the power draw of your equipment by interviewing you about your system and then drawing upon an extensive database of actual power measurements for equipment and peripherals. In addition, the UPS Selector has a database for actual power consumption of computer components such as processors and disk drives. This allows the UPS Selector to determine your load power requirement. The UPS Selector requests your preferences for run time, room for growth, and specific features you want. The UPS Selector has a mathematical model of every APC UPS that describes the product limitations and the run time of the UPS vs load. Using all of this information the UPS Selector can solve for the APC products that best match your requirements. The UPS Selector is even smart enough to assemble combinations of APC products including battery packs and other accessories to match your needs.

Does the UPS Selector recommend the lowest cost solution?
The UPS Selector attempts to determine the lowest cost solution when there are multiple options matching your requirements. It then provides other alternatives, which often differ by providing either slightly more features, more power, or more run time than your stated requirement.

How can the UPS Selector say my PC draws 60 Watts when I know it has a 110 Watt power supply in it?
The power supply rating of your computer is the maximum power it can supply. The actual power it is called upon to supply is set by the components inside your computer like the motherboard, accessory cards, and disk drives. Manufacturers always oversize the supply because A) it runs cooler, B) it lasts longer, and C) they need to be conservative since they don't have any contol over what you can put into the expansion slots. Therefore it is very common that a computer will only draw half of the rated value of the power supply.

What if I want to see more solution options for my system?
Back up from the recommendations to the preferences section and change your desired run time or your margin for future expansion, then re-submit. This is very likely to result in different recommendations and is a quite effective way to find other options you may wish to consider.