

Desiree Frontaine
1716 Boutade Ln
Austin, Tx. 78700
(512) 000-0000

John Arbors, Jr.
Waterloo Brewing Company
401 Guadalupe St.
Austin, TX. 78701
(512) 000-0000

Dear Mr. Arbors:

As we agreed two months ago, I have prepared this report for your company, Waterloo Brewing. Waterloo, at present, runs a Local Area Network (LAN), with a server and 4 dumb terminals. Currently, this system is protected with a surge suppression system, in the form of special wall receptacles, that trips a breaker if a spike occurs. There is no protection on the phone line. This report offers technical background information on an alternative power protection device designed specifically for businesses that use LANs in their day-to-day operations; that device is called an uninterruptible power supply (UPS). This report compares three of the top name brands in UPSs in a point-by point comparison and offers conclusions and final recommendations for the purchase of a UPS, as well as a glossary to help define terms that are unfamiliar.

Background on power supplies

To reduce the risk of losing data to power failure, many companies protect their servers with uninterruptible power supplies [4:110] . A UPS uses batteries to provide power to a connected computer in the event of a brownout or blackout. "Dirty power" is the industry term for changes, variances, and disturbances that occur during normal usage of utility provided power.

A perfect sine-wave can become system-shocking "dirty power" without notice and can cause extreme damage to data and computers alike. Other equipment nearby can produce "noise on the line" that can wreak havoc with a computing environment. IBM recently reported in a study of power sources that a typical processor encounters around 128 power problems a month [5] . These problems can be caused externally by brownouts or load switches or grid problems at the utility or caused internally by subtle disturbances from sources such as copiers, flourescent lights, faxes or even vending machines. Spikes, surges, sags, gaps, as well as electrostatic and electromagnetic interference attack your delicate electrical environment on a daily basis. UPSs provide reliable continous computer-grade AC power regardless of what happens to primary power sources [1;5] .

Features required by the UPS

The following sections lists the requirements as you described in our discussions about this project, and specifically requirements related to the hardware now in place at Waterloo Brewing

Company. You indicated that the cash outlay must be kept to between \$200.00 and \$400.00 and that the UPS must support the operating system already on the computer, which is Windows 3.1.

The hardware requires that this device be capable of running the server for 15-20 minutes, so that the manager on duty has time to effect an orderly shutdown of the system, including saving the various open ledgers and reports. To protect the computer and peripherals, the UPS should include voltage regulation, protection ports for the phone line that is connected to the computer modem, protection for the terminal connections, and a low battery indicator. The size of UPS needed is 600 VA. This number is arrived at by adding up the VA ratings of all the devices and peripherals and allowing another 40% for expansion of equipment and for fault tolerance. This allows the computer load to be 60% of the KVA rating of the UPS [4;5] .

Narrowing the Field

After looking at two dozen different brands of UPS, I have been able to narrow the field to the devices that had the features we were looking for, at the price we wanted, with the best reputation. Those companies in the order of their reputation are American Power Conversion Company, Fenton Industries, and Tsi Power Company. We will compare the Smart-UPS from American Power Conversion, the PowerPal 6000 from Fenton Industries, and the UPS-600 from from Tsi Power's Flexible series.

Comparison of the Uninterruptible Power Supplies

The following compares these UPS systems according to (1) price, (2) operating system compatibility, (3) server shutdown time, (4) voltage regulation, (5) phone ports and terminal connections, and (6) batteries and indicator lights.

Prices. All of the models fell within the target budget with:

- APC's Smart-UPS, with a rating of 660 VA, listed at \$344.00 on their Web site price list.
- Fenton's Powerpal, with a rating of 650 VA, listed at \$279.00 on their web site price list.
- Tsi Power's UPS-600, with a rating of 600 VA, listed at \$295.00 at Circuit City. Tsi does not offer on-line shopping.

Since all the models fell within the target range of your budget and since they all offer the total VA needed for this project, this point of comparison will have little effect on the final recommendation.

Operating system compatibility. The operating systems supported by these UPSs are as follows:

- APC's Smart-UPS are Windows, Windows 95, WinNT and Windows fro Workgroups. They also provide plug-and-play software.
- Fenton's Powerpal are Novell's Netware, WinNT, Windows 95, Windows 3.1 and OS\2. Fenton includes automatic shutdown software with their UPS.
- Tsi Power's UPS-600 are Novell's Netware, WinNT, Windows 95 and Windows 3.1.

Since all the models fell within the target range for this requirement, this point of comparison will have little effect on the final recommendation.

Server shutdown time. The times for server shutdown are as follows:

- APC's Smart-UPS is 25 minutes. The Smart-UPS also offers automatic shut down software.
- Fenton's Powerpal is 30 minutes. Fenton also has smaller battery backups that presumably could be used to keep the terminals up and running in the case of blackouts of short duration.
- Tsi Power's UPS-600 is 15 minutes. Tsi allows for expansion of the unit's batteries. The price for battery extension is \$64.95 and allows for an additional 15 minutes of backup time. Tsi also has smaller power packs for the terminals.

Fenton's Powerpal offers the longest time for shutdown. The optional automatic shutdown software offered by APC is of little use on the Squirrel system because of the procedures required to effect an orderly shutdown. The smaller battery packs offered by Fenton and Tsi are not capable of keeping the terminals up for more than 15 minutes. You would have to buy one for each of the terminals to boost the power at that location, and in the case of a complete blackout it would be better to perform the shutdown, and save the equipment from power sags and surges when the power comes back online. Fenton is the obvious choice for this point.

Voltage regulation. The fourth point of comparison involves voltage regulation. The specifications for each UPS are as follows:

- APC's Smart-UPS is full automatic voltage regulation which provides complete protection against extended brownouts or spikes without draining the batteries [2] .
- Fenton's Powerpal is built-in voltage regulation for brownout protection -- Powerpal "boosts" low voltages and "bucks" high voltages or spikes, thus extending battery life and reducing stress on the electrical equipment [3] .
- Tsi Power's UPS-600 is protection against high and low voltages [5] .

APC and Fenton both have automatic and full-time voltage regulation. Tsi has a standby switch or inverter and only turns on when the power drops to the level of the UPS-600's low impedance switch. In some cases, this may be too late for the data in stream or the process in progress and could result in a lack of protection in a critical area, such as in the case of lesser sags and gaps. The choices are APC or Fenton for this point.

Phone ports and terminal connections. The UPSs must also be compared in terms of the phone ports and terminal connections provided for the protection of the modem and for noise suppression on the terminal lines. The phone and terminal ports offered by:

- APC's Smart-UPS are RJ11 and 10-BaseT network cable ports with surge protection. The model listed offers 4 terminal ports and one phone port.

- Fenton's Powerpal are RJ11/RJ45 which includes the phone (RJ11) and the terminals (RJ45). Fenton offers surge protection for the phone lines and noise filters on the terminal lines.
- Tsi Power's UPS-600 are RJ11/RJ45. They also offer "line conditioning" which is essentially noise reduction and surge suppression or you may request a low impedance system with transfer for isolation. This system works as a switch, when the threshold set for the low impedance is hit the line is switched off to prevent damage to the equipment being protected by the UPS.

APC's terminal ports would need an additional adapter to make the port accept an RJ45 connection. Fenton offers no surge protection on the terminal lines. It is unlikely that a surge would hit a terminal first, but it's still in the realm of the possible. Tsi Power's system offers the most flexible and comprehensive coverage in this area. Of special interest is the low impedance switch on the terminal lines. This offers the protection needed if the terminal is hit with a surge before the server, the low impedance switch would shut down the terminal affected by the surge, without disrupting the operation of the server or the remaining terminals. Tsi Power is the choice for the fifth point.

Batteries and indicator lights. The options for batteries and indicator lights are as follows:

- APC's Smart-UPS are an LED light to indicate low battery power and hot-swappable batteries.
- Fenton's Powerpal offers a LED light to indicate low battery power and hot-swappable batteries.
- Tsi Power's UPS-600 offers an LED light indicator for low battery power and hot-swappable as well as battery extensions.

APC's hot-swappable batteries means you can change the batteries without turning off or disconnecting the UPS. Tsi Power's Battery extensions are a clincher on this point. The battery extensions are useful for systems that are planning for expansion. Remember that expansion can mean upgrading your server or adding peripherals, with this definition almost every system will experience expansion sooner or later. Tsi Power gets this point.

The following table summarizes the comparisons discussed in the preceding:

Categories	APC's Smart-UPS	Fenton's Powerpal	Tsi Power's UPS-600
<i>Price/voltage rating</i>	\$344.00/660 VA	\$299.00/650 VA	\$295.00/600 VA
<i>Operating system</i>	Windows 3.1	Windows 3.1	Windows 3.1
<i>Time allowed for shutdown</i>	25 minutes	30 minutes	15 minutes
<i>Voltage regulation</i>	Good	Good	Fair
<i>Phone & terminal ports</i>	Fair	Fair	Good
<i>Batteries & low-battery indicator</i>	Fair	Fair	Good

Conclusions

The following is a summary of the conclusions reached in the comparison section. A summary table is included between the primary and secondary conclusions section for quick reference.

1. All the units came in under the price cap.
2. All units are under the maximum price.
3. All units support Windows 3.1.
4. All units supported Windows 3.1, which is the operating system now in use on Waterloo's LAN.
5. In terms of actual time allowed for shut-down in case of complete power failure, Fenton Industries' Powerpal offers the longest time for shut-down at 30 minutes.
6. APC's Smart-UPS and Fenton's Powerpal both offer full automatic voltage regulation, which protects the computer and peripherals against spikes, sags, gaps and brownouts.
7. In terms of phone lines and terminals, Tsi Power's UPS-600 offered the most comprehensive options.
8. In terms of operation and the status indicators for the batteries, Tsi Power offered the widest range of options in this area as well.
9. APC's unit offers the best VA rating, but also carries the highest price.
10. APC offers good voltage regulation, but needs an adapter to allow for terminal connections to the unit.
11. APC also offers only fair coverage of options offered for batteries.
12. Fenton's Powerpal offers 650VA rating and is comparable in price to the lowest priced unit.
13. Fenton's unit supports Windows 3.1 and allows the longest time for shutdown. The voltage regulation is good and the phone and terminal connections are compatible.
14. Fenton offers only fair coverage of the options offered for batteries.
15. Tsi Power's UPS-600 only offers a 600VA rating for the lowest price, but that price is only lower by \$4.00.
16. Tsi Power's UPS-600 actually falls out of the running because of the increased cost of bringing the shutdown time up to the level needed. It does offer some nice options on the phone/ terminal ports and batteries. Finally, APC offers most of what Fenton offers for a higher price and only a 10VA increase for the money.
17. Tsi supports Windows 3.1, but only offers 15 minutes for shutdown, if a battery extension is not purchased. These battery extensions cost \$64.95 each and increase the shutdown time by 15 minutes. Tsi does offer some unique options for the terminal lines in the form of a switch on the line that can be triggered by a low impedance barrier, thus isolating the affected line, while allowing the system to continue running. The battery extensions are a plus when it comes to options for the batteries, as it allows for expansion of the system without purchasing additional units.
18. Based on the requirements and conclusions, the Fenton Industries' Powerpal is the best choice: it offers the highest VA rating for the price, while offering the most amount time allowed for the shutdown procedures.

Recommendation

Based on the conclusions reached in this comparison, Fenton Industries' Powerpal is the best UPS and is the recommended selection for Waterloo Brewing:

- It offers a good price and a VA rating of 650, which is 50 over what is needed when we use the formula described earlier.
- It supports Windows 3.1.
- It offers 30 minutes of shutdown time in the event of a complete blackout.
- Its voltage regulation is automatic and covers brownouts, surges, and blackouts.
- Its phone and terminal ports are of the type needed for the system that is in place.
- Its noise suppression on the terminal line and surge protection on the phone line should cover most occurrences encountered by Waterloo in their day-to-day operations.
- The Fenton includes a low battery indicator, which was one of the requirements, and enables the user to change batteries while the system is up and running.
- The Fenton company has a good reputation and can supply business references upon request through its computer web site.

Glossary of Terms

blackout. Total loss of utility power caused by excessive demand on the power grid, lightning storms, ice on power lines, car accidents, backhoes, earthquakes and other catastrophes. Effects include loss of current work in RAM or cache and possible loss of the hard drive file allocation table (FAT), which results in total loss of data stored on drive.

dumb terminals. A terminal that passively serves for input and/or output but performs no local processing.

KVA. VA times 1000.

noise. More technically referred to as electromagnetic interference (EMI) and radio frequency interference (RFI), electrical noise disrupts the smooth sine wave one expects from utility power. Electrical noise is caused by many factors and phenomena, including lightning, load switching, generators, radio transmitters and industrial equipment. It may be intermittent or chronic. Noise introduces glitches and errors into executable programs and data files.

sags. Also known as brownouts, sags are short term decreases in voltage levels. This is the most common power problem, accounting for 87% of all power disturbances according to a study by Bell Labs. Sags are usually caused by the start-up power demands of many electrical devices (including motors, compressors, elevators, shop tools, etc.) Electric companies use sags to cope with extraordinary power demands. In a procedure known as "rolling brownouts," the utility will systematically lower voltage levels in certain areas for hours or days at a time. Hot summer days, when air conditioning requirements are at their peak, will often prompt rolling brownouts. A sag can "starve" a

computer of the power it needs to function, and cause frozen keyboards and unexpected system crashes which both result in lost or corrupted data. Sags also reduce the efficiency and life span of electrical equipment, particularly motors.

single-phase VA rating. Volts times Amps = VA per device.

spike. Also referred to as an impulse, a spike is an instantaneous, dramatic increase in voltage. Akin to the force of a tidal wave, a spike can enter electronic equipment through AC, network, serial or phone lines and damage or completely destroy components. Spikes are typically caused by a nearby lightning strike. Spikes can also occur when utility power comes back on line after having been knocked out in a storm or as the result of a car accident. Spikes cause catastrophic damage to hardware and loss of data.

surge. A short term increase in voltage, typically lasting at least 1/120 of a second, resulting from presence of high-powered electrical motors, such as air conditioners, and household appliances in the vicinity. When this equipment is switched off, the extra voltage is dissipated through the power line. Computers and similar sensitive electronic devices are designed to receive power within a certain voltage range; anything outside of expected peak and RMS (considered the "average" voltage) levels will stress delicate components and cause premature failure.

watts-to-VA conversion. Watts times 1.35 = VA per device.

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