



## **Preventive Maintenance for UPS Systems**

We recommend 2-4 preventive maintenance (PM) visits per year based on the critical nature of the application, site visit, and customer specifications.

If four visits are determined to be required, two of these visits will mainly address battery conditions, while the other two will address both battery conditions and the uninterruptible power supply (UPS) operation. Battery and UPS operational maintenance conducted at the same time is considered a "major" PM visit, while battery only inspections are considered a "minor" PM visit. Battery only PM visit will incorporate a minor inspection of the UPS as described in the section titled "Scope of Work".

Major PM Visits will require that the UPS be put into "bypass" and isolated so the UPS can be safely inspected including its internal components. See UPS below.

### **Batteries**

During the maintenance of VRLA batteries, if at all possible, the UPS is left running, the batteries are isolated, and readings are then taken on the batteries. By isolating the batteries, we can safely test the open cell voltages and then apply a 100 amp load while checking voltage drops of each battery.

Normal battery voltages are 2.25 volts per cell or 13.5 volts DC for a "12" volt battery. Battery voltages under charge should be 13.5 volts on average for all batteries. After isolation, the open cell (non-charging state) should be slightly lower than 13.5. These readings are recorded and any discrepancies are noted. Depending on the size of the battery, the voltage will drop to 11 volts or so under load. All battery voltages under load are recorded.

Anything 8 VDC or less is considered bad and should be replaced soon. 4-8 VDC should be replaced very soon. Less than 4 volts should be replaced immediately, in which case, if a battery isn't immediately available, we would jump out the bad battery and adjust the float voltage accordingly. (This will depend on how many bad batteries are found and other factors)

Any maintenance free battery over four years old should be considered potentially at end of life. If the battery set is 5 years old or older, we do not recommend replacing one or two bad batteries. Under these circumstances we would recommend that all the batteries should be replaced.

Although we are aware of the use of impedance testing and "trending", after years of experience, we believe an actual load test is, by far, the most reliable indicator of a battery's condition.

While inspecting the batteries, we also check and correct any terminal corrosion, cable deterioration or other anomalies. We also check terminal connections for correct torque.

On systems where the battery can not be safely isolated, we will visually inspect the battery and do a unit self test where possible.

For wet cell applications, an extensive maintenance list is available.

### **Budgeting for Batteries**

Many customers have often been inconvenienced by unforeseen and costly battery replacements that were not originally accounted for on that year's budget. As part of our value proposition we provide ways to address this issue by utilizing the techniques above to determine the true life of the battery. (Further explained in value proposition)



## UPS

Preventive maintenance visits are scheduled bearing in mind that any lurking problems will be exposed. At best, problems will be fixed before they surface. Technicians will be entering the site keeping in mind that problems can surface at the time of the PM and cause problems. Fortunately, most UPS systems have built in safety features that prevent major problems from affecting the load. The odds of a major problem existing are slim if PM visits have been performed diligently in the past.

Minor PM visits usually do not require the UPS to be placed into “bypass” mode because the batteries can be isolated. This is dependent on the particular system and there are exceptions.

Major PM Visits involve first verifying that the UPS is functioning normally. We look at any annunciators on the UPS itself. Generally this would show us the input voltage and current, output voltage and current, output frequency, battery voltage and current, faults, history and other relevant information. We record these readings and, where possible, verify them with our meters. We also note the environmental conditions (heat, dust, clutter, humidity, etc.) and verify the operation of the cooling fans within the UPS. On parallel redundant systems, one module is taken off line, with the load still protected. On single module systems, the phase relationship between input and output is noted, and the system is then placed into bypass mode.

On single module systems, where possible, the system is placed into external bypass (Maintenance bypass, wrap around, global, etc.), the unit is shut down and input power is removed. If there is no external bypass, power is removed from the input, with the system still providing power through the internal bypass.

Once the system is isolated we open doors, remove covers and otherwise provide access to the internal components. Once a year we will perform a thermographic scan with an infrared camera (done on line when possible), at other times we will check internal component temperatures with an infrared temperature meter. We will visually inspect all components, cables, connections, circuit boards, etc. for any signs of overheating, damage, looseness or other problems. Any problems found are resolved immediately where possible. If necessary, other solutions are initiated and/or parts are ordered. Any known technical updates are performed.

We will vacuum and/or blow out dust and debris, inspect air filters and replace as necessary. Close inspection of capacitors will occur with meter testing where deemed necessary. (Sencore LC53 capacitor-inductor meter) All cables and connections will be inspected and checked for tightness and re-torqued where necessary. Seating of components and control wiring is checked.

When all maintenance or repairs are completed, the system will be started and proper operation will be verified. Any operational adjustments will be made. When approved by end user, the system will be placed on line, with proper readings verified once again. Any possible over loading, load imbalances, harmonic problems and other items will be recorded with the maintenance report and communicated to the appropriate on site personnel.

Completed reports will be emailed to the designated personnel within five days. Any recommendations, concerns and future scheduling will be addressed at that time.