

# Protecting UPS Installations from Major Power Disturbances

## HIGHLIGHTS:

Wherever the threat of major power line spikes or surges exists, due either to lightning, utility switching, or industrial machinery, Transient Voltage Surge Suppressors (TVSS), now referred to as Surge Protective Devices (SPDs), should protect UPS installations. The SPD should be located at the incoming power feed (switch gear or disconnect) and grounded to the utility ground outside the building as advised by FIPS Pub 94.\*

In addition, IEEE Standard 1100-2005, 8.6.5 "UPS system surge protection" states, "Lightning and other transient voltage and current-producing phenomena are harmful to most UPS equipment and to its served electronic load equipment. For example, the transient may reach the critical load via an unwanted activation of an unprotected static-switch bypass path around a UPS. Therefore, it is recommended practice that both the input circuit to the UPS and the associated UPS bypass circuits (including the manual maintenance bypass circuit) be equipped with effective Category "B" surge protective device, as specified in IEEE Std C62.41-1991. Low-inductance connections should be employed for this protection."

## SPDs protects UPS installations in four ways:

1. To protect the UPS itself. It is an expensive, critical and sensitive piece of equipment that is generally under-protected from major strikes.
2. To protect the load when the UPS is in bypass mode. This usually occurs more often than manufacturers and users would like.
3. To protect the load from a surge chain reaction. The first pulse puts the UPS into bypass, which leaves the load exposed to follow-on pulses that always occur with lightning.
4. To protect both the load and UPS in off-line UPS installations.

## Need for Surge Protection on UPS Installations

FIPS Pub 94 recommends that where the risk of major power line spikes, transients and noise is high (as in lightning areas, older industrial areas, or poor utility areas), two levels of surge protection should be installed:

1. Heavy-duty surge suppression units located at the main service entrance as the main line of defense against large, externally-generated destructive spikes. Clamping at that point prevents the worst surges from entering the building's wiring grid.
2. Sub-panel units on panels serving computer rooms and other sensitive equipment, as protection against the residual effects of major strikes and as a first line of defense against internally-generated transients and electronic noise.

While many UPS's provide adequate secondary transient and noise protection (additional transient and noise protection should be investigated on a case-by-case basis), most UPS's are not well protected against major high voltage spikes. UPS's are typically designed for "average" (actually, "better-than-average") power conditions to keep costs down. As a result, UPS's do not provide adequate protection for sensitive loads against destructive spike or transient conditions. Yet, the high cost of equipment typically

protected by the UPS, the high cost of disrupted operations or down time, and the high replacement cost of a UPS, all justify the investment in protection against spikes and high voltage transients. Therefore, where high voltage surges are a significant risk, either from lightning, utility switching, or industrial power problems, UPS installations should be protected by a SPD unit at the main switchgear and at subpanels supplying the UPS and other sensitive equipment.

### **Protecting the UPS from Major Surges**

As stated by UPS manufacturers, "the most common UPS malfunctions are shorted SCR's, communication failures, misfiring of an inverter phase by noise or by instantaneous overloads caused by a failed power component. Transients and moderate spikes do cause, or worsen, these problems." In addition, major spikes damage or destroy rectifiers, inverters, and bypass switches. Typically, when these problems occur, the UPS goes into the bypass mode, leaving the load unprotected from power problems. The SPD protects the UPS itself from the destructive effects of major surges. But that is not all it does.

### **Protecting the Load from Major Surges**

The SPD also protects the load whenever the UPS is put in the bypass mode, whether the UPS is in bypass intentionally or as a result of electrical problems. Yet the most important contribution of the SPD is to protect both the UPS and the load from the same high voltage spike! Major surges, especially those caused by lightning, rarely occur in single pulses. Almost all contain at least two, and most contain several. The average for lightning is four. These follow-through pulses are usually of major strength. Typically, unprotected UPS's are damaged by the first pulse in the surge, causing them to switch into bypass. Then the load is fully exposed to the disruptive or destructive effects of the follow-through spikes.

### **Protecting the Load in Off-line UPS Installations**

An economical UPS gaining in popularity is the off-line, smaller kVA-rated unit. In addition to the problems discussed above, this type of UPS provides no surge protection or noise filtering for the load even under normal operations. Off-line UPS installations, therefore, have exactly the same surge, transient and protection requirements as though the UPS were not there.

### **Specifying the SPD**

For UPS protection applications, a heavy-duty SPD should be installed at the main service entrance and a smaller unit at the panel supplying the load.

\*Federal Information Processing Standards Publication 94, "Guideline on Electrical Power for ADP Installations", National Technical Information Service, U.S. Department of Commerce. Springfield, VA 22161. See Chapter 7, PP 85-87.