Uninterruptible Power Supplies Keep Traffic Signals On

Illinois Works to Avoid Delays and Dangers from Outages

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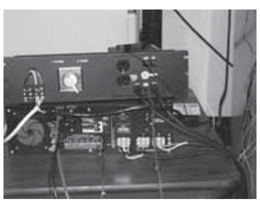
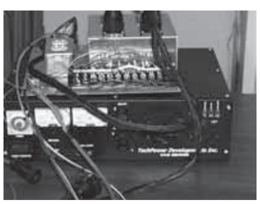
Power interruptions—brownouts and blackouts—can cause traffic signals to flash or to go dark. Traffic signals with light-emitting diode (LED) lamps consume less power and can operate on uninterruptible power supplies (UPSs)—or battery backups. UPSs function as a separate source to maintain a continuous supply of electric power to connected equipment whenever utility power is not available.

Problem

A traffic signal that is dark or flashing contributes to traffic congestion and jeopardizes safety for vehicles and pedestrians. Emergency vehicles are unable to preempt the operation of the nonfunctional traffic signal, experiencing unwanted delays. In addition, power interruptions render useless the signals that are interconnected with railroad crossings, which keep the tracks clear of vehicles before the arrival of a train. A power interruption lasting only a fraction of a second may send the signals into the flash mode, and the signals may continue flashing until manually reset.

Although other transportation agencies were realizing benefits from UPSs, the Illinois Department of Transportation (DOT) allowed only marginal use, noting that the performance had yet to be proved and that standard specifications were lacking. A survey conducted in 2000 found that only seven states had installed UPSs at traffic signals (*1*). Use is likely more widespread today.





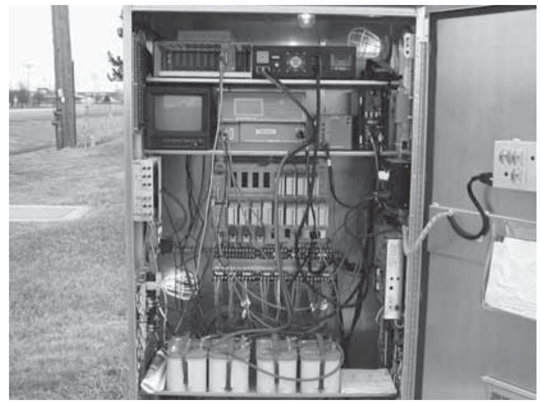
UPS units from two manufacturers undergo testing.

Solution

The research objective was to evaluate UPSs in terms of compliance with Illinois DOT specifications. Tests were conducted at the Traffic Operation Laboratory (TOL) at the University of Illinois, Urbana–Champaign. Compliance was determined in the contexts of the vendor literature, visual inspection, direct questions to the vendors, and tests at the lab. District personnel from Illinois DOT were involved in the evaluations and were informed about the findings.

Monitoring and testing of UPS units at subfreezing temperatures in a freezer.

The primary focus of the tests was to determine how long a UPS would operate under full load of approximately 700 watts, the power consumption of a traffic signal with LED signal heads, and at varying temperatures: room temperature of 24°C (75°F), a high temperature of 72°C (162°F), and a low temperature of −25°C (−13°F).



Installation of UPS and batteries in a cabinet's available space.

The tests also examined the switchover from line power to UPS and vice versa at specified voltages and for specified periods of time. The researchers recorded the battery recharge times and verified the opening and closing of contact switches under various conditions—such as signals on UPS, signals operating on UPS for 2 hours, and signals with 40 percent of the batteries drained.

Four vendors submitted their latest UPS models for the lab tests. All of the UPSs met the minimum requirement for maintaining 700-watt loads at room temperature for 2 hours. As expected, the UPSs operated longer at the high temperatures and significantly shorter at the subfreezing temperatures. The photographs on this and the facing page show the UPS units under testing, along with typical UPS cabinet installations.

Some of the recommendations that derived from the lab testing included the following:

1. Consider operating the traffic signals in the flashing or in the normal-and-flashing modes during

cold weather to extend battery life. The red-yellow-green signal operation is safer than the flashing mode, which is safer than dark signals. Operation in the flashing mode consumes only about half the power of the normal mode. At subfreezing temperatures, when the battery capacity is significantly reduced, entering the flashing mode early can prolong the battery life and delay dark signals.

2. Use heater pads to keep batteries warm at subzero temperatures.

3. Inform traffic operations personnel if a signal is on UPS. Unless the UPS contact switch is monitored, operations personnel would not know that the signals are operating on UPS or how much battery capacity remains. The signal controller can monitor the UPS contact switches, notify the operations personnel, and generate alarms automatically to the central computer if the signal status changes.

The evaluation reports for each of the UPS units are available online.[1]

Application

The compliance testing of the UPSs and the publication of the findings addressed most of the initial concerns of potential users, and UPS deployment has been on the rise in the state. Illinois DOT districts and the local municipalities increasingly specify UPSs, especially at high-priority traffic signals. Recent Illinois DOT policy requires the installation of UPSs when signals interconnected with railroads are first installed or are upgraded.

In 2006, 9 UPSs were installed at traffic signals on state highways, but the number increased to 43 in 2007. Additionally, approximately 365 UPSs have been installed with funding from the Department of Homeland Security at signals in the downtown Chicago Loop.

Benefits

UPSs prevent traffic signals from going dark or into the flashing mode after power interruptions. Maintaining the signals' red, yellow, and green operation reduces the problems with congestion, safety, emergency vehicles, and railroad crossings, described above. Although the benefits of reducing congestion and crashes with UPSs at traffic signals are obvious, research is needed to quantify the effects. Power interruptions vary widely with weather—such as lightning or high winds—as well as with the capacity margins of the local electrical system and the reliability of the electrical equipment.

The congestion and safety impacts of power interruptions also vary widely, depending on traffic volumes and roadway geometrics, with busier and larger intersections gaining greater benefits from more reliable traffic signal operation. Drivers must treat a dark traffic signal as an all-way stop, which has significantly less capacity than a traffic signal.

Crash statistics are unreliable, because most crashes occur at low speeds, and the police usually do not record crashes that result in property damage only. The reports for more severe crashes often do not indicate that the traffic signal was dark or that the crash occurred in a queue caused by a dark signal. Installing UPSs at intersections commonly traveled by emergency service vehicles and at those with sizable volumes of pedestrians—particularly pedestrians with disabilities—yield additional benefits.

Although these benefits are difficult to quantify, the life-cycle cost of a UPS is straightforward. Adding a UPS to a traffic signal costs less than $5,000, as long as the cabinets in use have sufficient room. The maintenance costs are minimal. The total quantifiable benefits from this research project would be the net benefit from a UPS times the total number of related UPS installations.

Acknowledgments

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Reference

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Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).

Installation of UPS in a separate, attached cabinet; the UPS unit is on the top shelf, and the batteries are on the middle and bottom shelves.

UPS unit and batteries in a piggyback cabinet; the design is suitable for retrofitting a signal cabinet for UPS equipment.

[1] See Traffic Operations Lab Series Nos. 7–9 and 16–17 at http://sftp.cee.uiuc.edu/research/tol/reports.html.