MICHIGAN
DEPARTMENT OF TRANSPORATION

SPECIAL PROVISION
FOR
TRAFFIC SIGNAL UNINTERRUPTIBLE POWER SYSTEM

SIG:EMS 1 of 7 APPR:HLO:NJB:05-09-24
FHWA:APPR:06-04-24

a. Description. This work consists of installing or removing an on-line, power conditioner and uninterruptible power system (UPS) with battery backup capability (with cabinet) designed for transportation and traffic applications including mounting brackets, hardware, fittings, cable, connectors, grounding, and other material necessary to complete the work. Furnish a UPS that is dual microprocessor controlled with a software driven power system and is compatible for installation within a traffic signal controller cabinet environment. Furnish a UPS that includes an inverter which operates as needed supplying clean regulated power (both voltage and frequency) to all loads, have full power factor correction, and be completely compatible with any type of auxiliary power generator, or a line-interactive UPS.

b. Materials. Furnish material meeting sections 918 and 921 of the Standard Specifications for Construction and the requirements of this special provision.

1. Traffic Signal UPS. Furnish a traffic signal UPS from the following list.

A. Clary SP 1250 LX or 2000LX corresponding to the wattage requirements specified on the plans.

B. Approved equal (AE). Ensure the AE is evaluated, tested, and approved per the MDOT New Traffic Signal Device Product Review Guidelines. The review time is not justification to delay the project.

2. Operation.

A. Furnish a UPS that can simultaneously produce a fully regenerated and regulated true sine-wave conditioned power output with a continuous and hot standby AC output or a line-interactive true UPS, that will provide a continuously regulated voltage to the load in line when on inverter mode.

B. Furnish a UPS inverter, as required to produce continuous, clean, regulated power to all loads that has a minimum operating efficiency of 92 percent or a line-interactive UPS that is 98 percent efficient in line mode and 83 percent efficient in inverter mode. Furnish a continuous power output for signals, controllers, and modems, etc.; and furnish a standby output for signals, if so required. Furnish a UPS capable of supplying power, up to the maximum load rating, to any combination of signal heads, whether incandescent, LED, or neon, by any manufacturer, regardless of power factor, without overdriving the LED heads which may cause early degradation, low luminosity, or early signal failure. Furnish a programmable digital delay timer for short-term battery use under full cycling operation.

C. Furnish a UPS that can utilize battery power in support of the system upon the loss of utility supplied power. In normal operation, ensure the UPS operates in the real-time true on-line mode with the inverter supplying power to all cabinet loads, at all times. Furnish a UPS that operates in hot standby mode with power transfer being accomplished in 100 milliseconds or less, if required. In the event of UPS failure and/or battery depletion, ensure the UPS drops out, and upon the return of utility power the traffic control system, defaults to a normal operating mode.

D. Furnish a by-pass switch that enables removal and replacement of the UPS without shutting down the traffic control system (i.e., “hot swap” capability). Ensure connectors are equipped with a “safety interlock” feature or finger-safe terminal blocks.

E. Furnish a UPS that includes an LED display on the front panel that is used to show various real time operational parameters of the UPS. Ensure the LED display operates in the two following modes; Normal Mode is the default mode for displaying real time UPS parameters, and Menu Mode is for accessing additional system information and for programming any modifiable UPS parameters. Ensure the programmable LCD is capable of providing the following information; Battery System Status; Power System; UPS System; UPS Information; Event Log; Time/Date; and Relay Status.

F. Utilize existing Flasher Modules and Flash Transfer Relays (FTRs).

G. Furnish a UPS that is fully compatible with police panel functions (i.e., “signals OFF” switch must kill the power to any field wiring even when on UPS/Battery power), to facilitate emergency crews and police activities.

H. Furnish a UPS that does not duplicate or take over flash operation or flash transfer relay functions, and can provide continuous, fully conditioned, or regulated pure sinusoidal AC power to all connected devices such as signal controllers, modems, communications hubs, *NTCIP* adapters and video equipment at all times.

I. Ensure the UPS is *NTCIP* capable, with optional standard adapter, and contains two external serial ports, or one serial port, and five dry contact terminal blocks located on the front panel of the UPS. Ensure the Signal serial port furnishes the user the option to select alarm output functions. Ensure these functions are open collector type contact closures or dry contacts the user can assign as signal utility interrupt, low battery and inverter active conditions, or utility failure indicator. Ensure these signals are capable of being interfaced to any manufacturer’s controller auxiliary alarm inputs or the Power Interface Module (PIM). Ensure the recommended standard (RS)-232 Signal port and Universal Serial Bus (USB) provides an intelligent interface for connection to optional software systems for monitoring and control, including internet connections.

J. Furnish a UPS that has full power factor correction under all operating conditions.

3. Components. Furnish a UPS that consists of three major components, the UPS module, a by-pass switch, and the battery system.

A. Furnish a UPS module that consists of the following:

(1) True on-line, double conversion, pure sine-wave, high frequency inverter utilizing insulated gate bipolar transistor (IGBT) technology or a line-interactive true

UPS utilizing field-effect transistors (FET).

(2) Three-stage, temperature compensated, battery charger.

(3) Digital microprocessor-based timer for programmable flash command requirements.

(4) Furnish dedicated harnesses with quick-release, keyed, circular connectors, and braided nylon sleeve over all conductors for connection from the UPS module to the by-pass switch and battery system or hard-wired AC interconnect cables and battery cable kit with individual battery fast-disconnects.

(5) Local display of power system status, UPS information, system status.

(6) Local and remote communications capabilities.

(7) An integrated PIM with external by-pass to support ease of connection.

(8) Be capable of accepting an *NTCIP*-ready adapter or a spread spectrum radio modem.

(9) A DB9F connector with true RS-232 monitoring and a USB connection for remote signal alarms and remote communications or one true RS-232 and five dry contact terminal blocks.

B. Furnish a mounting/configuration that consists of a universal design. Furnish a *NEMA* style mounting method that is accommodates shelf-mount or wall-mount, or rack-mount.

C. By-Pass Switch.

(1) Furnish a by-pass switch that safely transfers utility power into the UPS.

(2) Furnish a by-pass switch that contains a terminal strip for input and output power connections in addition to neutral and ground connections. Furnish a terminal strip that includes six sets of independent auxiliary contacts or six dry contacts for flash, delayed flash, and system monitoring functions. Auxiliary contacts may be mounted on the UPS and may consist of 5 dry contacts and 1, 48VDC contact to power an enclosure fan.

Ensure the by-pass switch is capable of connection to auxiliary power generators and furnishes a ground fault interrupter (GFI) outlet, or a standard 5-15R outlet. The generator transfer switch may be a separate Automatic Transfer Switch module, or a manual transfer switch mounted on the enclosure.

D. Battery System.

(1) Furnish a battery system that is comprised of extreme temperature, deep cycle, or float cycle, absorbed glass mat (AGM) or gel cell valve regulated lead acid (VRLA). Ensure batteries are certified to operate at temperatures from -40 °C to +71 °C.

(2) Furnish a battery system that has a minimum of 8 hours run time in the event of an AC power failure for an intersection operating with LED signals.

(3) Furnish batteries that are certified to operate at extreme temperatures -40 °F to 160 °F (-40 °C to 71 °C) and do not require any aid from external devices to cool or heat the batteries.

(4) Furnish batteries with keyed interconnect wiring harness, a minimum of five feet in length.

(5) Furnish an interconnect wiring harness cable that is protected with abrasion-resistant nylon sheathing and connects to the base module via a quick-release circular connector, or battery cable kit with Anderson Power style fast disconnect connector to UPS and individual battery fast disconnects.

(6) Furnish a circular battery connector that has interlocking pins to prevent turn-on if batteries are not connected and will shut off the UPS should the batteries be disconnected, or have a battery alarm that indicates the batteries are not connected.

(7) Ensure the battery construction includes heavy-duty, inter-cell connections for low impedance between cells, and heavy-duty plates to withstand shock and vibration. Ensure batteries provide 100 percent runtime capacity out-of-box. Each battery must meet its specification without the requirement of cycling upon initial installation and after the initial 24-hour top off charge.

(8) Ensure the top cover uses tongue and groove type construction and is epoxied to the battery case for maximum strength and durability.

(9) Furnish an external, stand-alone (base) pad or pole mounted outdoor cabinet enclosure to house the UPS system as shown on the plans. For the base mounted cabinet option, furnish a 15 inch minimum cabinet base riser. Ensure the cabinet includes adequate shelves to house the UPS and batteries. Ensure the cabinet includes a connection to interface with an auxiliary power generator should there be a power outage lasting longer that the run time of the UPS. Ensure the auxiliary generator connection is accessible from the outside of the cabinet enclosure. Alternatively, furnish a cabinet that has dimensions of 22 inches by 16.5 inches by 48 inches high and furnishes sliding (pull out) battery shelves that lock into position. Ensure the cabinet can house the UPS, transfer switch and batteries and is equipped with flush-mount generator plug door. Ensure the pad-mount pedestal option is 22 inches by 16.5 inches by 8 inches high.

4. Electrical Specifications.

Table 1: Input Voltage

Nominal Input Voltage	120 VAC, Single Phase
DC Battery Buss	48VDC, 72VDC or 96VDC
Input Voltage Range	85 VAC to 135 VAC for Double conversion or Line-Interactive input range 85 VAC to 175 VAC
Input Frequency	45 - 62 Hz (±5 percent)
Input Configuration	3 Wire (Hot, Neutral, Ground)

Input Current (Max. draw)	8.8 amps, PFC-1250VA or 14.6 amps, PFC-2000VA. Line-Interactive 1100 VA/W unit 15.5 amps and 2000 VA/W unit 20 amps
Input Protection	Input Fuse (20 amps) or circuit breaker. The circuit breaker on the 2000W/2000VA UPS must be 25 amps.

Table 2: Output Specification

Nominal Output Voltage	120VAC, Single Phase
Power Rating	1250VA/825W or 1100VA/1100W continuous 2000VA/1400W or 2000VA/2000W continuous
Output Voltage Regulation	±2 percent for 100 percent step load change and from High battery to Low battery condition in inverter operation
Output Frequency	50 or 60 Hz (±5 percent)
Output Configuration	Keyed, circular connectors and duplex receptacle or finger safe terminal block.
Output Wave Form	True Sine-wave
Overload capability	110 percent for 10 seconds 200 percent for 50 milliseconds
Fault clearing	Current limit and automatic shutdown
Short circuit protection	Current limit and automatic shutdown
Efficiency	92 percent at full load. Line-Interactive units 98 percent in line mode and 83 percent in inverter mode.
Load Power Factor	0.7 lagging through unity to 0.7 leading

5. Physical Specifications. Ensure module is no greater than:

A. Rack, Shelf and Wall Mount: Width = 19 inches, Depth = 10 inches, Height = 3.50 inches

B. By-Pass Switch: Width = 7 inches, Depth = 6 inches, Height = 4.5 inches

C. Weight: UPS: 35 pounds or less, Shipping weight: 40 pounds or less

6. Environmental Specification.

A. Furnish a UPS system, including batteries, that meets or exceeds *NEMA* operating temperature standards from -40 °F to 165 °F (-40 °C to 74 °C) during discharge.

B. Furnish a UPS system, including batteries, that is certified, and field proven to meet or exceed *NEMA* temperature standards. Furnish a certificate of compliance, from an independent testing facility, as requested by the Engineer.

7. Battery Specifications.

A. Furnish batteries that are the 41, 51, 80, 86, 100, 109 or 112 Ampere-Hour rating type.

B. Furnish batteries that meet *MIL SPEC B-8565J* for hydrogen gas emissions or

VRLA batteries designed to provide up to 99 percent recombination of hydrogen gas under normal charging conditions.

8. Communication, Controls, and Diagnostics.

A. Furnish alarm function monitoring through the UPS by using a standard DB-9F connector with open collectors (40V at 20 milli-Ampere) or dry contact terminal blocks indicating:

(1) Battery On;

(2) Time Out Battery On Alarm;

(3) Low battery; and

(4) Alarm.

B. Furnish both an RS-232 interface via a DB-9F connector and a USB connection to allow full interactive remote computer monitoring and control of the UPS function.

C. Furnish front panel controls that consist of no less than: Power On, Cold DC Start, Alarm Silence, Battery Test, UPS Self-Test, and DC/Battery Breaker.

D. Furnish a UPS that is programmable through a front panel keypad.

9. Reliability.

A. Ensure the calculated Mean Time Between Failures (MTBF) is 100,000 hours based on component ratings or for a line-interactive system the UPS system must have a Mean-Time-Before-Failure (MTBF) of 174,955 hours at a temperature of 25 °C (77 °F) and 103,030 hours at a temperature of 50 °C (122 °F) per *Telcordia SR-232*, 100 percent duty cycle, full load.

B. Ensure when the by-pass switch is included, the system MTBF increases to 150,000 hours.

10. Options.

A. Furnish a UPS-link, internally mounted simple transportation management protocol (STMP)/*NTCIP* adaptor.

B. Ensure that extended run times are possible via additional batteries.

C. Furnish a high rate battery charger for accelerated charging capacity for multiple battery strings. The high rate battery charger must be 15ADC with the line-interactive true UPS.

11. Serviceability and Maintainability. Mean-Time-To-Replace or Repair (MTTR).

A. Electronics. 15 minutes or less.

B. Battery System. 15 minutes or less.

12. Warranty. Furnish materials with a manufacturer's warranty/guarantee of 4 years minimum, transferable to the Department or the local agency responsible for the project, that the supplied materials will be free from all defects in materials and workmanship. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to acceptance.

c. Construction. Complete this work in accordance with sections 204, 818 and 820 of the Standard Specifications for Construction, as shown on the plans and as directed by the Engineer.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	**Pay Unit**
TS Uninterruptible Power System	Each