

**SECTION 685
UNINTERRUPTIBLE POWER SUPPLY SYSTEM FOR
TRAFFIC SIGNALS**

PART 1 GENERAL

1.01 SUMMARY

A. Description

1. This specification sets forth the minimum requirements for an uninterruptible power supply (UPS) system for providing reliable emergency power to a traffic signal intersection (vehicle and pedestrian) in the event of utility power failure or interruption.

B. Related Sections

1. FDOT Specification Section 620 (Grounding and Lightning Protection)
2. FDOT Specification Section 676 (Traffic Cabinets)
3. Section 630 Conduit
4. Section 635 Pull and Junction Boxes

1.02 REFERENCES

- A. NEMA Standards Publication TS 2-2016, Section 2
- B. UL Standard 1778, Uninterruptible Power Systems
- C. Miami-Dade County Traffic Signals and Signs Qualified Products List (TSSQPL)
- D. FDOT Approved Products List (APL)
- E. California Department of Transportation Qualified Products List (Caltrans QPL)
- F. Caltrans Transportation Electrical Equipment Specifications (TEES)
- G. Caltrans Specifications for Battery Back-Up System (TEES Chapter 4)
- H. Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12)

1.03 SYSTEM REQUIREMENTS

A. Performance Requirements

1. UPS system must:
 - a. be capable of providing continuous, fully conditioned, regulated, pure sinusoidal (AC) power to the traffic control signal system during all modes of operation except when the UPS is in bypass.
 - b. be capable of providing a minimum of 1000 watts @+25°C, continuous active output capacity, with a minimum of 80% inverter efficiency while running in Backup Mode

(on batteries). When operating in Backup mode, the system output must be 120 VAC \pm 5 VAC, pure sine wave output, \leq 3% THD, 60 Hz \pm 0.05 Hz.

- c. be capable of operating a signalized intersection (500-watt load at 120 V_{AC}) for a minimum of 6 hours of full runtime when utility power is disabled and under ambient temperatures of 25°C. The UPS system must switch the intersection to flash mode of operation when approximately 40% of battery charge is remaining, via relay contact connection points on front panel of unit. The UPS system must operate the intersection in the flash mode of operation (300-watt load at 120 V_{AC}) for at least an additional 2 hours.
- d. operate in hot standby mode with power transfer being accomplished in 40 milliseconds or less from disruption of normal utility line voltage to stabilized inverter line voltage from batteries. The same allowable transfer time applies when switching from inverter line voltage to utility line voltage. Loss of utility power, transfer from utility power to battery power, and transfer back to utility power must not interfere with normal operation of connected equipment. In the event of UPS failure or battery depletion, connected equipment must be energized automatically upon restoration of utility power. Removal and replacement of the UPS system components must not disrupt the operation of the equipment being protected. The UPS unit and the Batteries must be hot swappable. There must be no disruption of the critical load (Traffic Signal) when removing the UPS unit or batteries for maintenance.
- e. Double-conversion UPS systems
 - 1) Must additionally be capable of simultaneously producing fully regenerated and regulated, conditioned, True Sine Wave power and hot standby AC output, and have a minimum operating efficiency of 90%. Ensure the UPS is listed to the requirements of UL 1778. Upstream back-feed voltage from the UPS system must be less than 1 V_{AC}.
- f. Nickel-Zinc Battery UPS Systems
 - 1) UPS systems designed for use of nickel-zinc batteries must meet the more stringent or additional requirements of Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12).

B. Functional Requirements

- 1. Unless otherwise specified herein, UPS System must meet the requirements for functionality, displays, and controls specified in Section 3 of Caltrans Specifications for Battery Back-Up System (TEES Chapter 4) or Section 3 of Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12) for systems using nickel-zinc batteries.

C. Green Technology Battery Backup System

- 1. UPS Systems meeting the requirements of Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12) and all applicable requirements specified in this Section.

1.04 DOCUMENTATION

A. Manufacturers' Instructions

- 1. Include a UPS operation and maintenance manual in the cabinet where the UPS is installed that includes cabinet wiring schematics, electrical interconnection drawings, parts layout and parts lists.

2. Battery documentation and replacement information.
- B. Quality Assurance/Control Submittals
1. Production Quality Control Testing
 - a. Provide certification for each UPS System of satisfactory results for a (1) 100-Hour Burn-In-Period and (2) Visual Inspection as described Section 8 of Caltrans Specifications for Battery Back-Up System (TEES Chapter 4).

1.05 WARRANTY

- A. Special Warranty
1. Manufacturers must provide a manufacturer's warranty for the UPS system (including the batteries) covering defects for a minimum of five (5) years from the date of final acceptance by the Department. The warranty must include provisions for providing a replacement UPS or required component to be received by the Department within 10 calendar days of notification for any UPS found to be defective during the warranty period at no cost to the County.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Mechanical
1. All parts must be made of corrosion-resistant materials such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. All fasteners exposed to the elements must be Type 304 or 316 passivated stainless steel.
 2. All connectors must be keyed to prevent improper connection.

2.02 EQUIPMENT

- A. Use only Use UPS system equipment that meet the requirements of this Specification and are listed on the FDOT's Approved Products List (APL), Caltrans QPL and the Department's Traffic Signals and Signs Division's Qualified Products List (TSSQPL). Except that the UPS system cabinet is not required to be on the Caltrans QPL.

2.03 COMPONENTS

- A. UPS Unit
1. Displays, Controls and Diagnostics
 - a. The UPS system software must be programmable from the front panel of the UPS unit by means of a keyboard or momentary buttons allowing user to step through menu driven software.
 - b. Local and remote configuration and management of the UPS unit, including access to all user-programmable features as well as alarm monitoring, event logging, and diagnostic utilities must be provided.
 - c. Configuration and management functions must be password protected.

- d. Alarm function monitoring must include the following: loss of utility power, inverter failure, low battery, battery temperature, and inverter active/utility fail.
 - e. Must include a front panel display and controls that allows programming of configurable parameters, features, and functions without the need for another input device. The UPS must have visual indications for Power-On, Mode of Operation (utility power or inverter), Battery Status, Alarm Status, Load Levels, and AC Output Voltage.
 2. A RS232 port must be provided on the front panel of the UPS Unit.
 3. An Ethernet port (RJ45) for local control using a laptop PC and remote control via a network connection must be provided on the front panel of the UPS Unit.
 4. The UPS unit must include an event log that indicates the date and time of the following events: AC high, AC low, AC frequency high, AC frequency low, AC fail/blackout, overload, over temperature, battery voltage high, battery voltage low, battery disconnected, battery temperature high, temperature probe disconnected, and short circuit. The UPS event log must be able to store a minimum of 200 events.
 5. The UPS unit must include battery management functions that includes active or equalized balancing; monitoring of temperature, voltage, and amperage of charge and discharge; and temperature compensated automatic charging to maximize the life of the batteries.
 6. UPS system software must be provided for the operational needs of the UPS system. The user/operator must be able to access all system software via the Ethernet port and RS232 port on the front panel of the UPS unit. The user must be able to read logged events and/or change programmable parameters from the keyboard, laptop or local area network via the Ethernet port.
 7. Ensure a minimum of 6 sets of NO and NC single-pole double-throw dry contact relay closures are available on the front face of the inverter/charger and labeled so as to identify each contact. The relay closures must consist of:
 - a. A set of NO and NC contact closures must be energized whenever the unit switches to battery power. Contact must be labeled or marked as "On Battery" or equal.
 - b. A second set of NO and NC contact closures must be energized whenever the battery approaches approximately 40% of remaining capacity. This limit will determine when the unit will switch from normal operation to flash. Contact must be labeled or marked as "Low Battery" or equal.
 8. Nickel-Zinc Battery UPS Systems
 - a. UPS systems designed for use of nickel-zinc batteries must meet the more stringent or additional requirements of Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12).
- B. UPS System Batteries
1. Use only deep discharge sealed prismatic valve regulated lead acid AGM cell batteries except for approved systems except batteries for approved UPS Systems meeting the requirements of Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12) are required to meet the requirements of Section 6 therein.
 2. Individual batteries must be 12V type, and must be easily replaced and commercially available for purchase as common off the shelf equal.
 3. Batteries must indicate maximum recharge data and recharging cycles and manufacture defaults on the inverter must not allow the recharging process to exceed the batteries maximum values.

4. Batteries must be sealed and require no maintenance, cause no corrosion, and be capable of maintaining 80% of original capacity and performance for a minimum of five years.
5. Battery terminals must include a protective covering to prevent accidental spark or shorting.
6. Battery interconnect wiring must connect to the inverter unit via modular harness with red and black cabling that terminates into a typical power pole style connector. Harness must be equipped with mating power flag style connectors for batteries and a single insulated plug-in style connection to UPS unit. Harness must allow batteries to be quickly and easily connected in any order and must be keyed to ensure proper polarity and circuit configuration.
7. The battery wiring harness must allow 6 feet of separation between the UPS and its battery bank. Battery cables provided to connect battery to battery harness main cable must be a minimum of 24 inches. Battery harness must be sized accordingly with system requirements.
8. An integral lifting handle shall be provided on the batteries for ease of removal/installation.
9. Battery Monitoring System
 - a. The UPS system must use a temperature compensated battery charging system. The charging system must compensate over a range of 2.5 to 4.0 mV/°C per cell.
 - b. The temperature sensor must be used to monitor the temperature and regulate the charge rate of the batteries.
 - c. The UPS system must provide an alarm should the temperature sensor fail. Should the temperature sensor fail, the inverter/charger must not allow the UPS system to overcharge the batteries.
 - d. Recharge time for the batteries to 80% or more of full battery charge capacity must not exceed 20 hours at 70°F.
 - e. Batteries must not be charged when battery temperature exceeds 50°C ± 3°C.
 - f. The UPS system shall monitor battery strings within a system and set a fault indicator if battery voltage falls below normal operating voltages.
10. Nickel-Zinc Battery UPS Systems
 - a. UPS systems designed for use of nickel-zinc batteries must meet the more stringent or additional requirements of Section 6 of Caltrans Specifications for Green Technology Battery Back-Up System (TEES Chapter 12).

C. UPS System Cabinet

1. The UPS system cabinet must be capable of base mounting to its own foundation.
2. The cabinet must be NEMA type 3R all aluminum with stainless steel hardware that meets the requirements of FDOT Section 676 and includes shelves and rack rails to house all UPS system components including the UPS, batteries, harnesses, switches, surge protective device, power terminal block and a generator hookup with transfer switch. All system components of the UPS system must be housed within the UPS system cabinet.
3. The cabinet include a power panel with:
 - a. A main breaker and a breaker for the technician GFCI outlet. The main breaker must be 30 amps and provide protection for the UPS system components. The breakers must be Square "D" QUO 150 Series, or approved equal.

- b. A 20 amp, 120 volt, 60 Hz technician GFCI receptacle. The receptacle must be wired to utility power and not regulated by the UPS module.
 - c. A surge protective device must be installed within the cabinet where the supply circuit enters the cabinet in accordance with FDOT 620-2.7.1.
 - d. Separate neutral bus bar and equipment ground bus bar.
4. The utility line service must terminate to a 3 circuit termination block sized for #6 AWG wire.
 5. The UPS cabinet must allow a maintenance technician to safely insert power for traffic signal operation while the UPS or associated equipment is serviced or replaced.
 6. The cabinet must include a transfer switch and generator access panel in accordance with FDOT Section 676. The generator access door must not protrude more than 1 inch when closed.

2.04 SOURCE QUALITY CONTROL

A. Tests, Inspections

1. Environmental: UPS assemblies, including batteries, must provide continuous power with specified wattage and operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 2, Sections 2.2.7, 2.2.8, and 2.2.9.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install UPS assemblies in accordance with the manufacturer's recommendations. All equipment used to keep the intersection signalized must be backed up and protected by the UPS System.

3.02 FIELD QUALITY CONTROL

A. Site Tests, Inspection

1. Provide a field acceptance test plan to Engineer for approval at least 14 days prior to commencement of testing. After approval of the acceptance test plan, perform testing of the installed UPS equipment. Furnish all equipment, software, and supplies necessary for conducting the test.

END OF SECTION 685