Standard Specification for Uninterruptible Power Supplies

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TTS 806.200.01 SCOPE

This specification covers the requirements for a stand-alone Uninterruptible Power Supply (UPS) system that is capable of providing power and conditioning of the utility power supply to maintain the operations of electronic equipment at a typical traffic control signal in the event of a main utility power supply failure and/or voltage/frequency fluctuations.

The system is to provide 120VAC backup power and shall also provide power conditioning of utility power feed for the operation of a traffic control signal including those electronic components listed in these specifications within the Traffic control cabinet and LED vehicle and pedestrian displays. This specification includes requirements for both line interactive and double conversion topologies.

This specification details the requirements for a complete UPS System encompassing a UPS Control Unit, Automatic Transfer Switch, Batteries all to be contained in a stand-alone pad mount cabinet and any concrete work required for mounting the UPS. The UPS System shall be field-proven to withstand extreme northern climate conditions and shall maintain reliable operation under those conditions.

TTS 806.200.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

City of Toronto Standard Specifications

TS 1.00	Construction Specification for Maintenance of Traffic
TS 2.10	Construction Specification for General Excavation
TS 5.00	Construction Specification for Sodding
TS 5.10	Construction Specification for Growing Medium
TS 1350	Material Specification for Concrete
TS 801	Electrical Work – General
TS 802	Handwells
TS 803	Duct
TS 804	Cables
TS 806	Power Supply Equipment
TS 807	Footings and Sidewalk Bays
TS 809	Traffic Signal Controllers
TS 813	Grounding

American National Standard Institute (ANSI)

IEEE C62.41	Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

Canadian Safety Association (CSA)

C22.2 No. 94.2	Enclosures for Electrical Equipment, Environmental Considerations

National Electrical Manufacturers Association (NEMA)

NEMA TS 2	Version 03.07 Traffic Controller Assemblies with NTCIP Requirements
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)

National Transportation Communications for ITS Protocol (NTCIP)

NTCIP 1202 Object Definitions for Actuated Traffic Signal Controller (ASC) Units

Ontario Provincial Standards (OPS)

OPSD 2400.101 Warning Signs Outside Electrical Equipment

TTS 806.200.03 DEFINITIONS

For this specification, the following definitions and acronyms apply:

Automatic Transfer Switch refers to the component which provides the ability to switch to inverter mode in the event of a power loss and also provides the ability to isolate the UPS Control Unit and Batteries.

Battery means the standard 12 Volt battery wired in series to provide a string voltage, for example 4 batteries in series providing 48 V DC.

Battery Charge Management System means the device that monitors and manages and regulates charge rate to the batteries.

Boost means increasing the voltage when utility input power drops below a pre-configured threshold.

Buck means decreasing the voltage when the utility input power exceeds a pre-configured threshold.

Double Conversion means a UPS topology which converts input power from AC to DC and then back to AC to remove all power anomalies and provide a pure 120 V sine wave.

Inverter means a unit within the UPS Control Unit which converts the DC voltage to a 120 V AC output.

Inverter Mode means the operating mode when utility line power decreases below voltage thresholds and the battery charge is being supplied to the inverter.

Line Interactive means a UPS topology which regulates input power using a filter to suppress certain power anomalies and buck/boost the input as needed to provide a 120 V sine wave.

Uninterruptible Power Supply System (UPS System) means all materials and components detailed within this requirement that together provide a fully-functioning battery backup for the Traffic Signal Controller operations.

AC Alternating Current

AGM Absorption Glass Mat

ANSI American National Standard Institute

ASA American Standards Association

AVR Automatic Voltage regulation

CCTV Closed Circuit Television

CSA Canadian Safety Association

DC Direct Current

ESA Electrical Safety Authority

IEEE Institute of Electrical and Electronics Engineers

NEMA National Electrical Manufacturers Association

OESC Ontario Electrical Safety Code

SNMP Simple Network Management Protocol

STP Shielded Twisted Pair

THD Total Harmonic Distortion

TMS Traffic Management Section

TTD Toronto Transportation Drawing

TTS Toronto Transportation Specification

ULC Underwriter Laboratories of Canada

UPS Uninterruptible Power Supply

VRLA Valve Regulated Lead Acid

TTS 806.200.04 DESIGN AND SUBMISSION REQUIREMENTS

Shop drawings and specification sheets for the UPS Control Unit, UPS Automatic Transfer Switch, batteries, and UPS Cabinet shall be submitted to the Contract Administrator before completing an order. Manufacturer part numbers and descriptions of all equipment being supplied shall be included.

Production, fabrication, and shipping of the products shall not commence until all submitted items have been reviewed and approved.

The City currently utilizes Alpha and Econolite UPS.

TTS 806.200.05 MATERIALS

TTS 806.200.05.01 Operational Requirements

The UPS System shall be capable of maintaining traffic signal operations for a minimum of four (4) hours after which it shall be capable of maintaining a flashing signal display for a minimum of six (6) hours.

The UPS Control Unit and associated wiring shall be sized to accommodate operations per the minimum operating hours of normal and all-flash operations based on the intersections device loads.

The batteries shall be sized to support the minimum operational requirements identified in section titled "Flash Operation".

The batteries shall have a service life to provide the minimum operational requirements identified in section titled "Flash Operation" for the duration of the battery warranty period.

TTS 806.200.05.02 Flash Operation

The UPS System shall be capable of providing normal and flash mode operation for both NEMA TS 1 and NEMA TS 2 Controllers.

The flash operation shall utilize the existing flasher modules and flash transfer relay of the Traffic Signal Controller System. The existing flash function shall not be modified or duplicated by the UPS installation.

The flash operation shall utilize Auto Flash functions. In the event the Auto Flash is not supported, the Contractor may use the Local Flash function.

After four (4) hours of normal traffic signal operations, the UPS shall utilize a control relay to start flash transfer functions. All-flash operation shall operate for a minimum of six (6) hours.

The UPS and flash operation shall be compatible with the police panel/auxiliary panel and shall not limit the existing functionalities of these panels.

TTS 806.200.05.03 Battery Sizing Recommendations

The Contractor shall be responsible for ensuring the battery string will support the normal and flash operation for the durations specified herein. As the loads at each intersection may vary, the Contractor may consider referring to Table 1 to determine minimum battery requirements.

Table 1: Minimum battery requirements

Unit in the traffic signal system	Unit load
NEMA Controller Unit (per unit)	40 W
MMU or CMU (per unit)	20 W
BIU (per unit)	6 W
LED Vehicle Signal Head (per head)	7 W (red), 16 W (amber)
LED Ped Heads (per head)	9 W
Pushbutton (per unit, 8 buttons)	11 W
Detection Cameras (per camera)	18 W
Camera Interface	77 W
Radar Detectors (per detector)	7.6 W
Radar Interface	77 W
Loop Detectors (per loop)	1.5 W
Loop Interface	77 W
LED Blank Out Sign (per unit)	37.5 W
CCTV Cameras and Interface (per camera)	24 W
Camera Interface	77 W
In-cabinet Lighting (per cabinet)	3 W
UPS Unit (Inverter-Mode at 2%)	20 W

The load calculations are based on the maximum load condition.

TTS 806.200.05.04 Warranty

The equipment supplied as part of the UPS System including the control unit, the bypass switch, relay, cabinet enclosure, and associated equipment shall be under warranty for a minimum of three (3) years from the date of delivery.

The batteries supplied as part of the UPS System shall be under warranty for a minimum of five (5) years from the date of delivery. Batteries shall be considered defective if they deliver below 80% of the battery rating during the battery warranty period.

The period of warranty coverage shall, in no case, be less than the manufacturer's usual and customary warranty period. All warranties that are customarily issued by the Bidder or manufacturer shall be provided to the City.

The City, or its appointee, with the consent of the manufacturer, may, at the Supplier's discretion, make minor repairs. All other repairs under warranty shall be made by the manufacturer at no extra cost to the City.

TTS 806.200.05.05 Long Term Support

The Contractor shall ensure that the products offered under this contract will be supported for five (5) years after the warranty period. All components, including custom electronic components, shall be available to the City during this period. Should parts become obsolete or unavailable, the vendor shall propose an alternative solution for the City's approval. The proposed solution, repair method, and required parts shall be at no extra cost to the City.

TTS 806.200.05.06 System Hardware General

The UPS System and cabinet shall be designed to operate reliably in the adverse environment of roadside cabinets and shall meet or exceed all NEMA TS 1 or TS 2 environmental specifications.

The UPS System shall have demonstrated compatibility with existing traffic control systems and shall be able to provide a minimum of 1000 Watts (1.0 KW) of continuous power to the intersection based on the Operational Requirements identified in this specification.

Installed at a signalized intersection that utilizes all LED displays the UPS System shall be capable of maintaining normal signal display operations for a minimum of four (4) hours after which it shall be capable of maintaining an all-red flashing signal display for a minimum of six (6) hours.

The UPS System shall include full-time protection from sudden voltage increases with inrush protection and AC line filtering.

The UPS System shall accept an input AC Voltage ranging from 0 to 140 VAC single phase, 2 wire plus ground for automatic voltage regulation and/or inverter mode operation.

The UPS System shall consist of the following three (3) major components, UPS Control Unit, Transfer Switch and Batteries all contained in a stand-alone outdoor-rated cabinet to be supplied with the system.

UPS System shall be stand-alone and pad- or pole-mountable.

The UPS Control Unit shall have a transfer time from line to the battery and from the battery to the line of fewer than 60 milliseconds.

If any of the UPS system components fail or the batteries are depleted, the system shall automatically switch back to the utility line.

The UPS shall switch back to the utility line when power has been restored for a minimum of 15 seconds. This delay shall be a configurable parameter.

Switching from full signal operation to flash operation shall be determined by an adjustable timer circuit.

All products shall be CSA or ULC approved.

TTS 806.200.05.07 UPS Control Unit – Topology

The UPS System shall operate using either of the following topologies based on the item title identified:

TTS 806.200.05.07.01 *Line Interactive*

UPS Control Units with Line Interactive topology shall include Automatic Voltage Regulation (AVR) capabilities to adapt to provide Buck and Boost functions to maintain a 120 V AC pure sine wave.

TTS 806.200.05.07.02 *On-Line/Double Conversion*

The UPS system shall operate continuously converting the utility line AC input to DC voltage and back to 120 VAC. If the utility line power is lost, the inverter shall continue to provide 120 V AC power sourced from the batteries for an instantaneous/0 millisecond transfer.

TTS 806.200.05.08 UPS Control Unit – General Requirements

The UPS Control Unit shall provide voltage regulation at 120VAC ± 3 % under any line, load or battery condition with a frequency regulation of 60Hz ± 3Hz synchronized to the utility main.

The UPS Control Unit shall limit total harmonic distortion (THD) to 3% or less for linear loads.

The UPS Control Unit shall operate at a power efficiency greater than 80%.

The UPS Control Unit shall accept an input voltage of 85 to 140 VAC for automatic voltage regulation operation.

The UPS Control Unit shall be rack or shelf mountable based on the cabinet supplied with the system and shall be able to be mounted vertically or horizontally.

The UPS Control Unit shall include a digital display on the front face capable of displaying the following:

- Current status – normal vs. inverter/UPS mode operation
- Number of times the system switched to battery supply with the ability to reset
- Indicator for the total time on battery supply with the ability to reset
- Current battery capacity and charging status
- Battery voltage
- Battery temperature

The UPS Control Unit shall have at least five (5) contact closures located on the front panel to provide the following functions at a minimum:

- Battery operation On (“Inverter Mode”)
- Battery Low
- Timer – configurable to change state after a pre-determined time in Inverter Mode
- Alarm

- Fault

The UPS Control Unit shall contain or be able to interface with a thermostat circuit to monitor the cabinet temperature and battery heater mat temperature.

The UPS Control Unit shall have two breakers located on the front panel, one to switch power from the batteries ON/OFF and the other to switch AC utility line input ON/OFF.

A standard Ethernet port shall be provided to provide direct PC connection or connection over a network for system configuration setup, system log information and maintenance. The port shall be located on the front panel of the UPS Control Unit.

The UPS Control Unit shall provide all network hardware required to interface with the City's network via Ethernet network switch or cellular modem (by others).

The UPS Control Unit should have a WebUI interface for configuration.

The UPS Control Unit shall support SNMPv2 to provide status, alert, and alarm information

The UPS Control Unit shall be capable of providing the following status, alert, and alarm information through a network connection:

- UPS Status
- Battery Capacity
- Battery Full
- Battery Low
- Battery Empty
- UPS Cabinet Door Status
- Temperature Sensor Fail

The UPS Control Unit shall have a self-test feature and a set of battery voltage test points on the front panel.

The UPS Control Unit shall have a temperature-compensated battery charging system. A temperature sensor shall be used to monitor temperature and regulate the charge rate accordingly.

The UPS Control Unit shall not overcharge the batteries in the event of a temperature sensor failure.

The UPS Control Unit shall not charge the batteries when the temperature exceeds 50 OC.

The UPS Control Unit shall be approved by the Canadian Standards Association (CSA).

TTS 806.200.05.09 Bypass and Transfer Equipment

The UPS System shall have a Transfer/bypass Switch that is physically separate from the UPS Control Unit.

The Transfer Switch shall include a manual bypass switch to allow for utility power to bypass the UPS Control Unit allowing for "hot-swapping" while maintaining traffic signal operation.

When the switch is in Bypass mode, the utility line power shall feed directly to the traffic signal cabinet.

When the switch is in UPS mode, the utility line power shall be conditioned through the UPS Control Unit.

The UPS Transfer Switch shall include a designated input for generator power, in addition to utility power.

TTS 806.200.05.10 Battery System

The Battery System shall consist of all equipment to support battery operation including a battery charge management system, harnesses, wiring, heat mats, and batteries.

Batteries shall be sealed requiring no fluid top-up for maintenance purposes.

Batteries shall be Valve Regulated Lead Acid (VRLA) or approved equivalent. Alternative battery technologies will be considered provided they meet or exceed the technical, operational, and environmental requirements of these specifications.

VRLA batteries shall utilize an Absorption Glass Mat (AGM) or Gel Cell Type electrolyte.

Batteries shall be rated to operate between -40°C and 74°C.

Batteries shall come with a 5-year warranty. Batteries shall have a design-life that aligns or exceeds the warranty term.

Battery Leads shall connect to the UPS Control Unit using an Anderson-style connector and shall use red Wiring for positive (+) and black Wiring for negative (-) connections.

Battery harness shall be provided to allow connecting the battery bank into a single connection to the UPS Control Unit.

Batteries shall be protected by a circuit breaker.

Each battery shall be labelled with the date it was manufactured. Labels shall be visibly located on the top of the battery.

The battery shall be placed on a heater mat with all heater mats being supplied with AC power from the UPS Control unit.

Battery mats shall become inoperable with loss of line voltage.

Batteries shall be according to the requirements of Section 26, *Storage Batteries* of the Ontario Electrical Safety Code.

A battery charge management system shall be included providing the ability to manage and optimize charges based on the battery life cycle.

The battery charge management system shall include network communication capabilities to relay status and alarms.

TTS 806.200.05.11 Power Panel

A screw-in terminal block with surge protection shall be provided to manage power inputs and outputs from the utility service lines and wiring between the UPS and traffic signal controller cabinet. The terminal block may be installed in the UPS or traffic signal controller cabinet depending on the entry location of the utility service lines.

Surge protection shall be provided between the utility line voltage and connection to the UPS System. The surge protection device shall be accessible and installed external to the UPS System components.

The surge protection device shall be compliant with the latest version of IEEE C.62.41.

A panel-mounted fuse holder shall be installed after the load side breaker within the traffic controller cabinet power supply.

All wiring shall be continuous with no intermediate splices.

Only one wire shall be installed per terminal. Jumper pins may be used to connect adjacent terminals.

TTS 806.200.05.12 Isolation Relay

An isolation relay shall be provided to interface between the timer contact closure on the UPS Control Unit and the flash interface of the traffic signal controller.

The isolation relay shall be a 120 V AC coil rated for 10 Amps. The isolation relay shall be double-pole double-throw (DPDT).

TTS 806.200.05.13 Duplex Receptacle

A NEMA 5-15R duplex receptacle shall be installed within the Traffic Signal Controller Cabinet that is backed by the UPS System. If an existing receptacle exits (non-GFI), the Contractor shall re-wire the receptacle as needed to ensure it remains operational during normal and inverter mode operation.

A minimum of two (2) NEMA 5-15R receptacles shall be provided in the UPS Cabinet that is backed up by the UPS System. These receptacles may be present on the UPS Control Unit, otherwise, a new duplex receptacle shall be installed and securely mounted within the cabinet.

TTS 806.200.05.14 Ethernet Cable

A Cat 6 shielded twisted pair (STP) shall be provided and installed between the UPS and traffic controller cabinet and terminated on a surface mounted keystone jack.

TTS 806.200.05.15 UPS Cabinet

The UPS Cabinet shall be supplied with the UPS System and shall be a NEMA Type 3R or CSA-Type 3 cabinet constructed of 3.175 mm thick sheet aluminum.

The UPS Cabinet shall not exceed the following dimensions (H x W x D): 1422 mm x 635 mm x 432 mm.

The UPS Cabinet shall include a 200 mm riser base.

The UPS Cabinet shall be painted Munsell Grey (ASA 61 or ASA 70). Alternative paint colours may be accepted upon approval from the City.

The UPS Cabinet shall have one main door giving access to all components in the cabinet

The main door shall be hinged on the right side—when looking at the cabinet door from the front—with a continuous stainless-steel piano style hinge.

The hinges for the main door shall be of corrosion-resistant material.

The main door shall be equipped with a three-point latching mechanism with a Corbin lock number 5R3575-GR Keyway for the main door.

The UPS Cabinet shall be capable of being attached to a concrete pad using anchor bolts.

The UPS Cabinet shall come with all concrete pad mounting hardware including a neoprene gasket and template for the base of the cabinet that includes bolt pattern layouts for anchors/inserts.

The UPS Cabinet shall have a ventilation system per OESC standards.

The UPS Cabinet shall be outfitted with a door contact interfaced with an input relay on the UPS Control Unit.

The UPS Cabinet shall include a generator access door with an L5-30 F1 plug.

The UPS Cabinet shall include a document holder on the inside of the main door.

The UPS Cabinet shall be designed to support the UPS Control Unit and UPS Automatic Transfer Switch on the top section while supporting the battery system in the lower section.

The UPS Cabinet shall be capable of supporting all equipment.

The inside of the main door of the UPS Cabinet shall be labelled with a print of the manufacturer, cabinet model, and manufacture date.

TTS 806.200.05.16 Concrete

Concrete shall be according to TS 807.

TTS 806.200.06 EQUIPMENT – NOT USED

TTS 806.200.07 CONSTRUCTION

TTS 806.200.07.01 General Installation Requirements

The Contractor shall install the UPS based on the Contract Documents. Installations shall take a side-by-side installation approach. The Contractor shall not proceed with a piggy-back, standalone, or pole-mounted installation approach without approval from the City.

All wiring and grounding shall be installed and secured according to the manufacturer's requirements and according to TTD 808.230 Figure 6, TS 801.100, TS 813.100 and Ontario Electric Safety Code.

Adequate slack shall be provided for all wiring to support maintenance activities.

The UPS cabinet fan shall remain powered in both normal and inverter mode operation. The Contractor may utilize dry contact on the UPS Control Unit for fan operation.

The UPS generator switch shall be left in the ON position to allow for external generator connection without requiring access to the cabinet.

TTS 806.200.07.02 Installation Configuration

The Contractor shall refer to the Contract Documents for the recommended installation approach.

TTS 806.200.07.03 Side-by-Side Installation

The Contractor shall install the UPS Cabinet side-by-side with the Traffic Signal Controller Cabinet in accordance with TTD 808.230 Figure 1, Figure 2, and Figure 4.

For existing installations on a concrete pad, the pad shall be extended – retrofit installation.

TTS 806.200.07.04 Standalone Installation

The Contractor shall install the UPS Cabinet on a standalone pad adjacent to the Traffic Signal Controller Cabinet pad in accordance with TTD 808.230 Figure 1.

TTS 806.200.07.05 Piggy-Back Installation

The Contractor shall install the UPS Cabinet bolted to the rear side of the Traffic Signal Controller Cabinet in accordance with TTD 808.230 Figure 3.

For existing installations on a concrete pad, the pad shall be extended – retrofit installation.

TTS 806.200.07.06 Existing Sidewalk or Concrete

A UPS mounted to an existing concrete sidewalk shall have a bead of caulking on all four sides to keep out moisture and small insects.

When there is no concrete base, there shall be a relief/saw cut, where the concrete is cut around that UPS base 50 mm from the 3 sides and 50 mm deep, and then filled with expansion joint filler.

TTS 806.200.07.07 New Concrete or Extension of Existing Pad

All concrete for new pads and extensions of existing pads shall be produced according to TS 1350.

TTS 806.200.07.08 Battery Wiring and Installation

Batteries and associated mats shall be placed on a clean, flat surface within the UPS cabinet free of any debris.

Battery terminals shall be sprayed with an anti-corrosion coating sealant. The sealant shall be flexible, water-proof rubber.

Battery installation shall be in accordance with subsection 26-510 (Battery installation) of the Ontario Electrical Safety Code (OESC).

Battery wiring shall be in accordance with subsection 26-512 and 26-514 of the OESC.

TTS 806.200.07.09 Existing Utility Power

Existing utility service cable shall be disconnected from the traffic controller and rerouted to the UPS system utility input. In the event there is not enough slack in the existing utility service cable and with the approval by the Contract Administrator, new power service cable shall be run from the existing power disconnect box to the UPS system.

The Contractor shall provision for either situation accordingly within the basis of payment based on the Contract Drawings or pre-bid site investigation or both.

TTS 806.200.07.10 Operational Equipment

The following equipment, at a minimum, shall be powered by the UPS during a power interruption:

- Controller Unit
- Malfunction Management Unit
- Detector Panel
- SCOOT Adaptive Signal Control Equipment
- Non-Intrusive Detector Equipment
- RESCU CCTV Camera Equipment
- Network Communications Equipment (Ethernet switches, modems)
- UPS Cabinet Fan

The following equipment shall NOT be powered by the UPS during a power interruption:

- UPS Cabinet Heater
- Traffic Signal Controller Cabinet Environmental Controls, such as fan, heater and so on.
- UPS Battery Heat Pads

The Contractor shall confirm with the Contract Administration the requirement of the UPS to support any other equipment not explicitly listed during a power interruption.

TTS 806.200.07.11 System Configuration Requirements

The Contractor shall be responsible for configuring the UPS parameters according to City's requirements and updating the UPS to the latest released firmware for the duration of the UPS Control Unit warranty term.

The Contractor shall provide the Contract Administrator all configured parameters and login credentials for the equipment.

The software configuration shall include details specific to the intersection including TCS number (to be provided by the City) and intersecting roadways.

The contract closure associated with the timer shall be configured to four (4) hours, which would initiate the all-flash operation.

The UPS shall be configured to switchover from inverter mode to normal operation when the utility line has been restored for fifteen (15) seconds.

TTS 806.200.07.12 Integration Requirements

The Contractor shall be responsible for integration into the City's traffic monitoring system via SNMP. The Contractor shall coordinate with the City and vendor in gathering all required MIBs and other information to allow for the real-time monitoring features identified in this specification.

The Contractor shall be responsible for verifying integration of the UPS and communications link in the field and centrally at the City's Traffic Management Centre. The Contractor shall simulate fault conditions to ensure they are reflected at the TMC via SNMP.

TTS 806.200.07.13 Tagging and Labelling

All cabling shall be tagged/labelled and separated utilizing flexible liquid-tight non-metallic conduit as required by the Ontario Electrical Safety Code.

Tags/labels shall be secured to the cable, and not loosely tied.

Tags/labels shall be printed in block letters with text that is at least 10 mm high.

The following labelling shall be provided:

- UTILITY LINE IN – utility power coming in from service power supply at the terminal block.
- LINE TO UPS - power going to the UPS System at the terminal block.
- LOAD SIDE FROM UPS – power coming from the UPS System at the terminal block

- “UPS TIMER CONTACT” – line at the flash operation relay in the Traffic Signal Controller Cabinet.
- “UPS-BACKED” – on all receptacles that are backed-up by the UPS.
- The exterior of the UPS Cabinet and Traffic Signal Controller Cabinet shall be affixed with signage per OPSD 2400.101.
- The UPS Control Unit shall be affixed with a sticker on the front panel detailing the installation date and associated contract number.

TTS 806.200.07.14 Training

The Contractor shall provide training to City personnel and its partners on the UPS System operation and maintenance.

TTS 806.200.07.15 System Documentation

The Contractor shall provide system drawings of the UPS system including layout and wiring diagrams.

The Contractor shall provide two (2) sets of system manuals/documentation. One (1) set shall be left on-site within the UPS Cabinet. The second set shall be provided to the City or Contract Administrator.

The cabinet schematics shall also be updated, and a copy provided to the City. The Contractor shall be responsible for providing certified as-built drawings within three (3) weeks of successful system acceptance.

TTS 806.200.08 QUALITY ASSURANCE

TTS 806.200.08.01 General Requirements

All work shall be done according to applicable Electrical Safety Authority (ESA) standards. The Contractor shall be responsible for all ESA inspections and any rectifications required as a result of the inspections at no extra cost to the City.

The Contractor shall carry out, document, and provide all testing documentation in a format similar to the provided Table 2.

Table 2: Testing documentation format

<table>
<tr><td colspan="2">Item:</td><td colspan="2">Tester:</td></tr>
<tr><td colspan="2">Item Description:</td><td colspan="2" rowspan="2">Date:</td></tr>
<tr><td colspan="2">Test:</td></tr>
<tr><td colspan="4">Test Set-up:</td></tr>
<tr><td>Clause</td><td>Test Procedure</td><td>Expected Result</td><td>Actual Result</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Witnessed By:</td></tr>
<tr><td colspan="4">Reviewed and Approved By:</td></tr>
</table>

The Contractor shall be responsible for submitting all test plans in advance of testing for review and approval.

TTS 806.200.08.02 Proof of Concept Testing

The Contractor shall test and provide proof that the proposed UPS System is capable of meeting the specifications and requirements of the City. All new configurations shall require Proof of Concept Testing as identified in this section. A configuration should be considered new if any component differs from a previous configuration, for example Control Unit model, battery type and size, and so on.

TTS 806.200.08.03 Bypass Switch and Charging Test

The Contractor shall be required to test the complete functionality of any new UPS system configuration before field deployment. The test(s) shall include a generator connectivity test and testing of the bypass and transfer switch(s).

TTS 806.200.08.04 Full Signal Operation for Four (4) Hours Minimum

The Contractor shall set up the UPS system in the shop with a functional traffic control cabinet and apply a 900W load (Traffic Controller + Extra Load = 900W) to the system and let it run for a minimum of four (4) hours on battery supply. The system shall provide a 120 VAC output continuously for the four (4) hour period at a minimum. Voltage measurement of the system output and battery string shall be recorded every half hour with a total of eight (8) measurements for the four (4) hour period.

TTS 806.200.08.05 Flashing Operation for an Additional Six (6) Hours

After four (4) hours, the voltage of the UPS system output shall be checked and recorded. A Single Pole Double Throw (SPDT) dry contact (N/O or N/C) representing the timer on the UPS Control Unit should change state at this point triggering the intersection to go into flash. Wiring between the Traffic Signal Controller Cabinet and the low battery contact is to be determined by the Contractor and shall be documented with a wiring diagram and submitted to the Contract Administrator. Use of a 10A SPDT relay between the UPS low battery contact and the traffic control cabinet terminal used for flash operation is suggested. Voltage measurement of the system output and battery string shall be recorded every half hour with a total of twelve measurements for the six (6) hour period.

TTS 806.200.08.06 Automatic Voltage Regulation (AVR) Test

A varying voltage based on manufacturer's AVR specifications shall be supplied to the UPS system and the output shall maintain 120 VAC @ 60Hz. Supplied voltage and the corresponding output shall be recorded. At least four (4) recordings shall be made for a supply voltage up to a maximum of 20% less than 120 VAC and for a supply voltage up to a maximum of 20% greater than 120 VAC respectively for a total of eight (8) recordings.

TTS 806.200.08.07 Post-installation Testing

TTS 806.200.08.07.01 *System Integration Testing*

For UPS systems connected to the City's network, the Contractor shall coordinate with the City Traffic Operations Centre to verify the UPS status and associated alerts/alarms are visible on the Operations software platform.

TTS 806.200.08.07.02 *Activation Testing*

After installation, the Contractor shall document the utility line input voltage and the UPS output voltage. The Contractor shall demonstrate the operation of the UPS system to City staff by shutting off utility power and allowing the intersection to run on back up supply for a minimum of one (1) hour. The transition (60 milliseconds or less) from utility supply to back up supply should not cause any changes in the signal operations and the intersection shall not go into flash operation at this time. A traffic control person shall be on-site during activation.

TTS 806.200.08.07.03 *System Acceptance Testing*

System Acceptance Testing shall consist of verification that every specification item in this document along with all required tests have been successfully completed. The Contractor shall provide a System Acceptance Test Plan at least four (4) weeks before testing for approval.

The Contractor shall notify the City and Contract Administrator at least two (2) weeks in advance of any testing activities to allow for witnessing.

TTS 806.200.09 MEASUREMENT FOR PAYMENT

TTS 806.200.09.01 Uninterruptible Power Supply

For measurement purposes, a count shall be made of number of UPS units installed.

TTS 806.200.10 BASIS OF PAYMENT

TTS 806.200.10.01 Uninterruptible Power Supply – Item

Payment at the Contract Price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.