

**REVISION OF SECTION 202  
REMOVAL OF TRAFFIC SIGNAL EQUIPMENT**

**Section 202 of the Standard Specification is hereby revised for this project as follows:**

**Subsection 202.03 shall include the following:**

The Contractor shall safeguard any salvageable materials designated by Denver Traffic, and shall be responsible for the expense of repairing or replacing damaged or missing material until it is delivered to the City and County of Denver Traffic Maintenance Yard at 5440 Roslyn Street.

Designation of salvageable equipment and times for delivery of such items shall be coordinated with Denver Traffic (contact Chris Lillie at 720-865-4066 or Greg Salazar at 303-591-7146).

Signal operations shall be maintained at each of the project intersections throughout construction.

**Subsection 202.04 shall include the following:**

Removal of the traffic signal equipment shall include signal poles (without luminaries), pedestal poles, footings, span wire cable, traffic signal controller and cabinet, pedestrian push button, cabinet footings, all attachment hardware, and all incidental equipment, except as noted on plans. All existing foundations and pull boxes shall be removed and back-filled. All wiring shall be removed from existing conduit and the conduit shall be abandoned in place.

Xcel Energy shall remove all signal poles with luminaries attached. Xcel Energy will remove only the signal pole and luminaries, and the Contractor shall remove the remainder of the traffic signal equipment, as noted in the plans. The Contractor shall coordinate with Xcel Energy for these removals and is referred to the Project Special Revision "Utilities" herein.

All "Light Emitting Diode" (LED) signal lenses in existing signal faces shall be removed prior to the removal of the signal face. These LED lenses shall be protected from damage and delivered to 5440 Roslyn Street, Denver. This work shall be included in the cost of Removal of Traffic Signal Equipment and will not be paid for separately.

Times for delivery to the maintenance yard shall be coordinated with Denver Traffic Engineering Services at (720) 865-4000.

**Subsection 202.12 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Removal of Traffic Signal Equipment	Lump Sum

**REVISION OF SECTION 613  
ELECTRICAL CONDUCTOR IDENTIFICATION**

**Section 613 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 613.08 shall include the following:**

All electrical conductors shall be tagged as follows:

Electrical conductor cable tags shall be located below the termination in the base of the streetlight, in the pull box, in the pedestal, and at the point of termination to existing facilities of the Local Utility Company supplying electrical service. The tags shall be attached with a cable tie. The information written on the tag shall include the direction and approximate length of cable, feeds running from where and to, etc.

Each incoming conductor shall be individually color coded with one (1) tape mark, while outgoing conductors shall have two (2) tape marks.

Example:

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FEEDS TO PULL BOX	FEEDS FROM XFMR
50' NORTH & 75' WEST	250' SOUTH & EAST
THEN TO HIGHWAY SIGN	200' WEST
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Uniform tags are available in a Tag Kit. \*The Tag Kit consists of: 100 tags, 3-part yellow with 1 hole, 100 black nylon ties and 1 black Sharpie pen.

<b><i>Manufacturers</i></b>	<b><i>Catalog Numbers</i></b>
Uticom Systems Inc.	U5025Y1
Panduit	
3M	
Or approved equal	

**Subsection 613.11 shall include the following:**

Electrical conductor tagging will not be paid for separately, but shall be included in the cost of wiring.

## **REVISION OF SECTION 613 ELECTRICAL CONDUIT – GENERAL**

**Section 613 of the Standard Specifications is hereby revised for this project as follows:**

Add the following to subsection 613.07:

Directional boring is the preferred method of conduit installation.

All conduit bends, including factory-installed bends, shall not have a bend radius less than six times the inside diameter of the conduit.

The excavations required for the installation of conduit or cable shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, landscaping, sprinkler systems and other improvements. Trenches shall not be excavated wider than necessary for the installation of the electrical appurtenances. Excavation shall not be performed until immediately before installation of conduits. The material from the excavation shall be placed in a position not to cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

Trenches shall be made with a rock-wheel or other machine capable of cutting a narrow trench (4") so as to allow traffic to pass over prior to back filling. The machine shall be equipped with shields to direct the spoil downward and away from passing vehicles, workmen and pedestrians.

Off-street trenches shall be back-filled with the same material that was removed and shall be compacted and shaped to match the surrounding surface. On-street trenches within ALL roadway areas shall be back-filled with CDOT approved Structure Backfill (Flow-Fill) and capped with 9" minimum of Hot Mix Asphalt Pavement (Patching) in accordance with Section 403 and City and County of Denver Street Cut Regulations if applicable. If surrounding pavement depth is greater than 9 inches, the HMA (Patching) depth shall match the existing pavement.

All surface materials including sprinkler systems, landscaping, shrubs, sod grass, and native growth vegetation which is disturbed by trenching and back-filling operation shall be restored in kind equal to or exceeding the original conditions.

All conduit runs that will not have a copper conductor installed shall have a #14 AWG stranded copper conductor placed inside for locating purposes. Locating conductor and tape will not be measured and paid separately, but shall be included in the unit price for conduit.

Conduit shall always enter a pull box, hand-hole, or any other type structure from the direction of the run only.

All conduit shall be fully compatible with fiber optic cable. Plastic conduit shall be Schedule 80 in the diameters shown on the plans. Each conduit shall be equipped with a pull tape and each bore shall have a copper tracer wire of at least 14 gauge.

Each conduit shall be equipped with either a pull rope or pull tape, depending on the length of conduit between pull boxes.

Each conduit with a length greater than 400' between pull boxes, shall be equipped with a pull tape. The pull tape shall have a minimum tensile strength of 1250 lbs. and be of a design and manufacture that prevents cutting or burning into the conduit during cable installation.

## **REVISION OF SECTION 613 ELECTRICAL CONDUIT – GENERAL**

Each conduit with a length of 400' or less between pull boxes shall be equipped with a pull rope or pull tape. The pull rope shall have a minimum tensile strength of 1250 lbs.

Plastic PVC conduit shall be certified by the manufacturer as meeting ANSI/UL 6 and 651. The manufacturer shall be ISO 9000 compliant.

If the contractor is unable to jack or bore the conduit at the lengths shown on the plans from pull box to pull box, all splice couplings and associated work to splice the conduit shall be included in the cost of this item. This shall include excavation down to the required depth of conduit at the splice location. Also included in the cost of this item are all landscape repairs, which will be required after excavation of conduit at all splice locations. All splice couplings shall be water and air tight and installed at a depth to match the remaining run of conduit. No elevation difference will be allowed. Splices shall be kept to a minimum and all locations shall be approved by the City. Additional pull boxes shall not be substituted for splices.

All conduit bends, including factory-installed bends, shall not have a bend radius less than six times the inside diameter of the conduit.

Conduit plugs for sealing conduit shall also be supplied and installed in all open conduit ends as soon as the conduit is installed. Plugs shall be durable, fabricated from no metallic parts, be of the split design to allow removal and reinstallation around in-place cables and be easily removable and reusable. Plugs shall be capable of being installed by hand without any tools and shall provide a water and air tight seal of at least 100 psi and shall cause no damage to the cable when installed.

At some locations (as illustrated on the Plans or in these specifications, or as directed by the Engineer), new conduits shall be installed in an existing pull box. At these locations, the Contractor shall carefully excavate around the pull box and install the new conduit in the pull box in a manner that meets the requirements of this Special Provision. The Contractor shall not damage the existing pull box. If the existing pull boxes or concrete collars are cracked or damaged during conduit installation, the Contractor shall be required to replace either or both conforming to the requirements of the contract at no additional cost.

### **Subsection 613.10 shall include the following:**

Electrical Conduit will be measured by the linear feet of conduit and installed in accordance with these Special Provisions, the Project Standards or as directed by the City. Electrical Conduit will include groundwork, sweeps, pull cord, copper tracer wire, adapters, fittings, splice couplings, conduit plugs (for conduits both with and without fiber optic cable), equipment, labor, and all other items necessary to complete the work.

**REVISION OF SECTION 613  
ELECTRICAL CONDUIT – GENERAL**

**Subsection 613.11 shall include the following:**

**Pay Item**

2" Electrical Conduit (Bored)

3" Electrical Conduit (Bored)

**Pay Unit**

Lineal Foot

Lineal Foot

## **REVISION OF SECTION 613 PULL BOXES – GENERAL**

**Section 613 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 613.07 shall include the following:**

Pull boxes Type A and Type B shall be used in all signal conduit installation. Pull boxes shall be made of fiberglass reinforced polymer concrete designed to support a minimum service load of 20,000 pounds over a 10 inch by 10 inch square. The pull box shall have a detachable cover with a skid-resistant surface and have the words “TRAFFIC” or, “ELECTRIC” cast into the surface. Painting the words shall not be accepted. The cover shall be attached to the pull box body by means of screw-in bolts and shall have two lift slots to aid in the removal of the lid. Non-standard bolts shall not be used.

All traffic communication pull boxes shall have the words “TRAFFIC COMM” physically impressed (not painted) on its top. The interconnect pull boxes or Pull Box (Special) shall be the Type C pull box. The covers shall be attached to the pull box body by screw-in bolts and shall have two lift slots to aid in the removal of the lid.

All concrete collars, footings, and location marker supports shall be Portland Cement Concrete Class B and shall be in accordance with Section 601.

Pull boxes that are to be in traveled ways shall be outfitted with traffic bearing lids rated for HS 20-44 loads. The pull boxes shall have a special concrete footing extending 8 inches around the outside and 6 inches around the inside of the pull box bottom, as shown in the plans. Pull boxes installed in dirt or landscape areas shall have a 12 inch wide by 6 inch thick concrete collar placed around the top in lieu of the concrete footing, as shown in the plans.

When the plans call for a fiber optic cable location marker to be installed at the pull box location, the concrete foundation support for the location marker shall be placed monolithically with the concrete collar.

Pull Box (Surface Mounted) shall be metal type with a hinged front door and have at least a NEMA 3R rating. The hinged door shall be provided with both a weather tight seal and a key lock mechanism. Surface mounted pull boxes shall be of the dimensions shown in the plans, and shall be mounted on or embedded into hard surfaces such as bridge decks, concrete barriers, retaining walls, or buildings, as shown on the plans. Surface mounted pull boxes shall be attached using 3/8-inch epoxy anchors or other methods, as approved by the Engineer. Surface mounted pull boxes shall not be used for ground installations.

**Subsection 613.11 shall include the following:**

Pull Boxes Type A and Type B will not be measured or paid for separately but shall be included in the cost of conduit.

**REVISION OF SECTION 613  
PULL BOXES – GENERAL**

**Subsection 613.12 shall include the following:**

**Pay Item**

Pull Box (Special) Type C

**Pay Unit**

Each

Pull Box (Special) Type C shall include the removal of any existing pull box, installation of the new Type C pull box, modification of conduit ends, restoration of disturbed surface materials, and all other work necessary to complete the installation. All work necessary for the removal and installation of Pull Box (Special) will not be measured and paid for separately but shall be included in Pull Box (Special).

Pull Box (Special) will be paid for on the basis of the number of pull boxes installed.

**REVISION OF SECTION 613  
LIGHTING**

**Section 613 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 613.02 shall include the following:**

Highway lighting materials and equipment for installation and modifications shall be compatible or interchangeable with standard materials and equipment as stocked by XCEL.

Lighting materials and equipment that are compatible with that stocked by XCEL are as follows:

Curvilinear Luminaries on City and County of Denver traffic poles:

Manufacturer	Catalog Numbers
Gardco	CA2213120250HPSFGPPC1069 Mast Arm Fitter
Kim Lighting	CCS25A3/250HPS 120/FG-P/A-25MAF
Sterner	FTA25A103HP250S120NS-RF2

Contractor shall submit a lighting materials list to XCEL for approval prior to ordering (Steve Smith, at 303-571-3945).

**Subsection 613.08 shall include the following:**

At least one grounding electrode shall be installed adjacent to each light standard. Wiring shall be a 120/240 volt or 120/208 volt, 3-wire system with individual luminaries wired for 120 volts.

**Subsection 613.11 shall include the following:**

Luminaries HPS (250 Watt) lighting will not measure and be paid for separately, but shall be included in the cost of the Traffic Signal Poles.

**REVISION OF SECTION 613  
ELECTRICAL METER PEDESTAL CABINET AND BASE**

**Section 613 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 613.07 shall include the following:**

New traffic signal installations require an electric meter pedestal cabinet and base for the traffic signal. The electrical meter shall be furnished by XCEL. The Contractor shall furnish and install the electric meter cabinet and pedestal base at the locations as show on the plan and in accordance with the City and County of Denver’s standard. The cost of the meter base is paid for separately.

**Subsection 613.10 shall include the following:**

Electric Meter Pedestal Cabinet and Base will be measured and installed in accordance with these Special Provisions, the Project Standards or as directed by the City. The Electric Meter Pedestal Cabinet and Base installation will include groundwork, sweeps, pull cord, copper tracer wire, adapters, fittings, splice couplings, conduit plugs, equipment, labor, and all other items necessary to complete the work.

**Subsection 613.11 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Electric Meter Pedestal Cabinet and Base	Each

**REVISION OF SECTION 614  
CLOSED CIRCUIT TELEVISION CAMERA (TRAFFIC MONITORING)**

**Section 614 of the Standard Specifications is hereby revised to include the following:**

**Subsection 614.01 shall include the following:**

This work consists of the installation of a closed circuit television camera at the locations shown on the plans.

**Subsection 614.08 shall include the following:**

(m) Closed Circuit Television Camera (Traffic Monitoring)

Closed circuit television camera shall be the Panasonic WV-NS954 CCTV IP Camera or an equivalent IP (Ethernet) camera as approved by the City and County of Denver Traffic Engineering Services. The following accessories shall be provided for each IP camera: Panasonic PAPM3 Pole Mount Bracket; Panasonic POD9CW Dome Housing (wall mount); and Altronix T2428100 24 VAC transformer.

**Subsection 614.10 shall include the following:**

The closed circuit television camera shall be installed in accordance with the details shown in the plans and in accordance with manufacturer's recommendations. The Contractor shall deliver the camera and accessories to the City and County of Denver's Traffic Operations Department at 5440 Roslyn, Denver, Colorado at least 4 weeks prior to installation for the camera calibration and set up. The Contractor shall pick up the camera and shall install it at the proper location. The Contractor shall make arrangements for a City and County of Denver Traffic Operations' representative to be on-site to ensure proper installation.

**Subsection 614.13 shall include the following:**

Closed circuit television cameras will be measured by the actual number of closed circuit television cameras that are installed and accepted. All accessories shall not be measured pay for separately, but shall be included in the cost of the closed circuit television cameras.

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Closed Circuit Television Camera (Traffic Surveillance)	Each

Payment will be full compensation for all labor, materials, accessories, and equipment required to complete the work.

**REVISION OF SECTION 614  
CONCRETE FOOTING (TRAFFIC SIGNAL POLE)**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.08 shall include the following:**

(m) Traffic Signal Pole Footings: Concrete foundations for all traffic signal poles and traffic signal-light poles shall conform to City and County of Denver Signal Standards and Details Latest Revision.

**Subsection 614.10 (e) shall include the following:**

Installation of concrete signal pole footings shall conform to the requirements of Section 503.

**In Subsection 614.13, delete the second sentence and replace with the following:**

Precast foundations used for traffic signal light poles without mast arm will not be measured or paid for separately but shall be included in the cost of the traffic signal light poles (no mast arm).

Drilled caissons used as foundations for traffic signal poles with mast arm will be measured by the number of individual footings installed complete in place and paid for as Concrete Footing (Traffic Signal Pole).

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Concrete Footing (Traffic Signal Pole) (36" Diameter)	Lineal Foot
Concrete Footing (Traffic Signal Pole) (48" Diameter)	Lineal Foot

**REVISION OF SECTION 614  
EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.08 shall include the following:**

**System Description:**

The emergency vehicle traffic signal priority control system shall enable designated vehicles to remotely cause the traffic signal controller to advance to and/or hold a desired traffic signal display by using existing controller functions. The control shall be activated at a minimum distance of 548.6M (1,800 feet) along an unobstructed "line of sight" path. The control shall not terminate until the vehicle is within 12.2M (40 feet) of the detector or at the intersection.

The system shall consist of the following components:

- A. Vehicle Emitter which shall be mounted on the emergency vehicle and shall transmit optical energy signals only in the forward direction. If the municipality presently uses optical pre-emption, the emitters shall be of the same manufacture currently used by the City and County of Denver Fire Department.
- B. Phase Selector (minimum 2 channels) which shall cause the signal controller to advance to and/or hold the desired traffic signal display for the emergency vehicle. A pre-emption system chassis shall house two phase selectors.
- C. Optical Detector which shall be mounted on or near a traffic signal and shall receive the optical energy signals generated by the Vehicle Emitter.
  - 1. Detector (Type A), 1 Direction, 1 Channel
  - 2. Detector (Type B), 2 Direction, 1 Channel
  - 3. Detector (Type C), 2 Direction, 2 Channel
- D. Detector Cable (Optical).

**System Operations:**

- A. The operating sequence shall be initiated when the optical detector receives the required optical energy signal from the Emitter.
- B. The phase selector shall cause the traffic signal controller to advance to and/or hold the desired traffic signal display for the emergency vehicle.
- C. The phase selector shall cause the controller to advance to and/or hold the desired traffic signal display even if the optical energy signals cease before the desired display is obtained.
- D. The phase selector shall allow the traffic signal controller to resume normal operation within ten seconds after optical energy signals cease if the optical energy signals cease after the desired traffic signal display is obtained.
- E. The phase selector shall not respond to optical energy signals from an emergency vehicle if it is already processing optical energy signals from another emergency vehicle.

**REVISION OF SECTION 614**  
**EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM**

**System Components:**

A. Vehicle Emitter:

The emitter assembly consists of an emitter and power supply and an emitter control switch assembly. The emitter assembly is mounted on a vehicle and produces a flashing optical signal when in operation. The following shall apply to the vehicle emitter:

1. Shall operate on ten to fifteen volts DC input voltage, but shall not be damaged by input voltage surges up to twenty-five volts DC.
2. Shall be controlled by a single on/off switch that requires no other adjustments by the operator. The on/off condition shall be indicated by a light located adjacent to the switch.
3. Shall be automatically disabled or de-activated by one or a combination of the following: seat switch, emergency brake switch, door switch, and transmission safety switch.
4. Shall operate over an ambient temperature range of minus 34O C to plus 60O C. (minus 30O F. to plus 140O F.)
5. Shall operate in 0 to 95 % humidity.
6. Shall be a pulsed optical energy source with a controlled repetition rate.
7. Shall not generate voltage transients on the battery input line which exceed battery voltage by more than four volts.
8. Shall produce optical energy in a cone of not more than 90 degrees horizontal and not more than 30 degrees vertical. The detectors and/or phase selector shall not sense a pre-emption signal from an emitter outside this cone.

**B. Optical Detector:**

The optical detector receives the high intensity optical pulses produced by the emitter. These optical energy pulses are transformed by the detector into appropriate electrical signals which are transmitted to the phase selector. The optical detector is mounted at or near the intersection in a location which permits an unobstructed line of sight to vehicular approaches. The units may be mounted on signal span wires, mast arms or other appropriate structures. The following shall apply to the optical detector:

1. Shall produce optical energy in a cone of not more than 90 degrees horizontal and not more than 30 degrees vertical. The detectors and/or phase selector shall not sense a pre-emption signal from an emitter outside this cone.
2. Shall be of solid state construction.
3. Shall operate over an ambient temperature range of minus 34O C to plus 60O C. (minus 30O F. to plus 140O F.)

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**EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM**

4. Shall have internal circuitry potted in a semi-flexible compound to ensure moisture resistance.
5. Shall operate in 0 to 95 % humidity.
6. Shall have a cone of detection of not more than 13 degrees. The detector and/or phase selector shall not sense a pre-emption signal from an emitter outside this cone.

**C. Phase Selector:**

The phase selector supplies power to and receives electrical signals from the optical detector. When detector signals are recognized as a valid call, the phase selector causes the signal controller to advance to and/or hold the desired traffic signal display. This is accomplished by activating the pre-empt input to the controller.

The phase selector is capable of assigning priority traffic movement to one of two channels on a first-come, first-serve basis. Each channel is connected to select a particular traffic movement from those normally available within the controller. Once a call is recognized, "commit to green" circuitry in the phase selector functions so that the desired green indication will be obtained even if optical communication is lost. After serving a priority traffic demand, the phase selector will release the controller to follow normal sequence operation. The following shall apply to the phase selector:

1. Shall include an internal power supply to supply power to the optical detectors.
2. Shall have minimum two-channel operation with the capability of interfacing with an additional phase selector for expansion of channels of operation.
3. Shall have adjustable detector range controls for each channel of operation, from 12M (40 feet) to 548M (1800 feet).
4. Shall have solid state indicator lights for power on and channel called.
5. Shall operate over an ambient temperature range of minus 34O C to plus 60O C (minus 30O F. to plus 140O F.)
6. Shall operate in 0 to 95 % humidity.

**D. Detector Cable (Optical):**

The following shall apply to the detector cable:

1. 3-Conductor cable with shield and ground wire.
2. AWG #20 (7x28) stranded.
3. Individually tinned copper strands.
4. Conductor insulation: 600 volt, 75 deg. C (167O F.).

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5. 1 Conductor-yellow; 1 Conductor-blue; 1 Conductor-orange.
6. Aluminized Mylar shield tape or equivalent.
7. AWG #20 (7x28) stranded uninsulated drain wire
8. DC resistance not to exceed 11.0 ohms per 305M (1000 feet).
9. Capacitance from one conductor to other two conductors and shield not to exceed 157pf/M (48pf /ft.).
10. Jacket: 600 volts, 80 deg. C (176O F.), minimum average wall thickness - 1.14mm (.045").
11. Finished O.D.: 7.62mm (0.3") max.

**System Interface:**

System shall be capable of operating in a computerized traffic management system when appropriate interfacing is provided by the computer supplier.

**General:**

The Contractor shall furnish the manufacturer the phasing diagrams indicating controller sequence and timing.

The Contractor shall secure from the manufacturer a guarantee for the equipment for a period of sixty (60) months, which time shall commence from the date of delivery. Manufacturer shall certify upon request that all materials furnished will conform to this specification. The manufacturer or his designated representative shall be responsible for determining and setting all required range and emitter intensity for the emergency vehicle operation.

**Construction Methods:**

All equipment except the vehicle emitter assembly shall be installed and wired in a neat and orderly manner in conformance with the manufacturers' instructions. The vehicle emitter assembly shall be delivered to a designated City representative.

Installation of the vehicle emitter assembly shall be the responsibility of the City and County of Denver Fire Department.

Traffic signals owned and maintained by the State that have optical pre-emption equipment owned and maintained by the town shall have an Auxiliary Equipment Cabinet (AEC) attached to the controller cabinet. The optical pre-emption equipment shall be housed in the AEC. Traffic signals owned and maintained by the town do not require an AEC to house the pre-emption equipment.

Detector cables shall be continuous with no splices between the optical detector and the AEC.

Detector locations shown on the plan are for illustration purposes only. Exact location shall be determined by the contractor or the designated representative for the best possible line of sight.

## **REVISION OF SECTION 614 EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM**

If not present in an existing traffic controller cabinet, the following items shall be installed and connected, in conformance with the current Functional Specifications for Traffic Control Equipment, “D” Cabinet Requirements (Pre-emption Type):

- Controller “D” harness and adapter.
- Pre-emption termination panel with terminal block and relay bases.
- Pre-emption disconnect switch, mounted on the emergency switch panel (on inside of cabinet door).
- Pre-emption test buttons, mounted on the pre-emption termination panel.

All connections from the phase selector to the “D” harness and to the cabinet wiring shall be made at the termination panel. The termination panel shall have AC+ Lights, AC-, and a switched logic ground. The switched logic ground feeds all the pre-empt inputs to the phase selector. When switched off by the pre-emption disconnect switch, the traffic controller shall not be affected by pre-empt calls from the optical pre-emption system. A minimum of two test buttons shall be provided. If there are more than two pre-empt runs, a button for each shall be installed. A chart or print out indicating the program steps and settings shall be provided along with the revised cabinet wiring diagrams.

Test the Pre-emption System According to the following Guidelines:

1. Notify the system owner/user, such as the Municipal Fire Chief or City Traffic Engineer, of the scheduled inspection
2. Request a fire department representative and an emergency vehicle, which has an emitter to conduct the test. If not available, the contractor shall provide an emitter.
3. In the presence of the Engineer and the municipal representative, test each pre-empted approach with the emergency vehicle. Test the following items of the system:
  - Confirm that the emitter activates the phase selector and the phase selector activates the correct pre-emption input to the controller.
  - Confirm adequate range. The traffic signal must be pre-empted to green sufficiently in advance of the emergency vehicle arrival. The vehicle emitter shall initiate pre-emption at a minimum distance of 548.6M (1800 feet).
  - Confirm there are no false calls. Keep the emitter active as the emergency vehicle passes through the intersection. No other optical detectors shall sense the strobe.
4. Document the test. Provide the Engineer and, upon request, the municipality copies of the test results.

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EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM**

If a malfunction is found or the system needs adjustment (such as range, emitter intensity, or detector location), schedule a follow-up test. Repeat the above steps for all approaches that did not pass.

All adjustments such as emitter intensity, phase selector range, sensitivity, detector placement, shall be made at the intersection by the contractor so that the optical pre-emption operates correctly with other major manufacturers' equipment currently owned by the town.

**Subsection 614.13 shall include the following:**

Emergency Vehicle Traffic Signal Priority Control System units shall include a four-channel card and the number of detectors as shown on the plans. Emergency Vehicle Traffic Signal Priority Control System shall be measured and paid by the number of intersections at which the system is installed. The item shall include all labor, materials, and ancillary hardware required to provide a fully functioning system to the satisfaction of the Engineer.

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Emergency Vehicle Traffic Signal Priority Control System	Each

## **REVISION OF SECTION 614 INTERSECTION DETECTION SYSTEM (CAMERA)**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.01 shall include the following:**

This work consists of furnishing and installing a fully-functional video detection system at the intersection as specified on the plans.

**Subsection 614.08 shall include the following:**

### **System Hardware:**

The machine vision system hardware shall consist of three components: 1) a color, 22x zoom, MVP sensor; 2) a modular cabinet interface unit; 3) a communication interface panel. Additionally, an optional personal computer (PC) shall host the server and client applications that are used to program and monitor the system components. The real-time performance shall be observed by viewing the video output from the sensor with overlaid flashing detectors to indicate the current detection state (on/off). The MVP sensor shall optionally store cumulative traffic statistics internally in non-volatile memory for later retrieval and analysis.

The MVP shall communicate to the modular cabinet interface unit via the communications interface panel and the software applications using the industry standard TCP/IP network protocol. The MVP shall have a built-in, Ethernet-ready, Internet Protocol (IP) address and shall be addressable with no plug in devices or converters required. The MVP shall provide standard MPEG-4 streaming digital video. Achievable frame rates shall vary from 5 to 30 frames/sec as a function of video quality and available bandwidth.

The modular cabinet interface unit shall communicate directly with up to eight (8) MVP sensors and shall comply with the form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack providing up to thirty-two (32) inputs and sixty-four (64) outputs or a 170 input file rack providing up to sixteen (16) contact closure inputs and twenty-four (24) contact closure outputs to a traffic signal controller.

The communication interface panel shall provide four (4) sets of three (3) electrical terminations for three-wire power cables for up to eight (8) MVP sensors that may be mounted on a pole or mast arm with a traffic signal cabinet or junction box. The communication interface panel shall provide high-energy transient protection to electrically protect the modular cabinet interface unit and connected MVP sensors. The communications interface panel shall provide single-point Ethernet connectivity via RJ45 connector for communication to and between the modular cabinet interface module and the MVP sensors.

### **System Software:**

The MVP sensor embedded software shall incorporate multiple applications that perform a variety of diagnostic, installation, fault tolerant operations, data communications, digital video streaming, and vehicle detection processing. The detection shall be reliable, consistent, and perform under all weather, lighting, and traffic congestion levels. An embedded web server shall permit standard internet browsers to connect and perform basic configuration, maintenance, and video streaming services.

## **REVISION OF SECTION 614 INTERSECTION DETECTION SYSTEM (CAMERA)**

There shall be a suite of client applications that reside on the host client / server PC. The applications shall execute under Microsoft Windows XP or 7. Available client applications shall include:

- Master network browser: Learn a network of connected modular cabinet interface units and MVP sensors, display basic information, and launch applications software to perform operations within that system of sensors.
- Configuration setup: Create and modify detector configurations to be executed on the MVP sensor and the modular cabinet interface unit.
- Operation log: Retrieve, display, and save field hardware run-time operation logs of special events that have occurred.
- Software install: Reconfigure one or more MVP sensors with a newer release of embedded system software.
- Streaming video player: Play and record streaming video with flashing detector overlay.
- Data retrieval: Fetch once or poll for traffic data and alarms and store on PC storage media.
- Communications server: Provide fault-tolerant, real-time TCP/IP communications to / from all devices and client applications with full logging capability for systems integration.

### **MVP Sensor:**

The MVP sensor shall be an integrated imaging color CCD array with zoom lens optics, high-speed, dual-core image processing hardware bundled into a sealed enclosure. The CCD array shall be directly controlled by the dual-core processor, thus providing high-quality video for detection that has virtually no noise to degrade detection performance. It shall be possible to zoom the lens as required for setup and operation. It shall provide JPEG video compression as well as standard MPEG-4 digital streaming video with flashing detector overlay. The MVP shall provide direct real-time iris and shutter speed control. The MVP image sensor shall be equipped with an integrated 22x zoom lens that can be changed using either configuration computer software. The digital streaming video output and all data communications shall be transmitted over the three-wire power cable.

**Power:** The MVP sensor shall operate on 110/220 VAC, 50/60Hz at a maximum of 25 watts. The camera and processor electronics shall consume a maximum of 10 watts and the remaining 15 watts shall support an enclosure heater.

**Detection Zone Programming:** Placement of detection zones shall be by means of a PC with a Windows XP or 7 operating system, a keyboard, and a mouse. The PC monitor shall be able to show the detection zones superimposed on images of traffic scenes.

The detection zones shall be created by using a mouse to draw detection zones on the PC monitor.

Using the mouse and keyboard it shall be possible to place, size, and orient detection zones to provide optimal road coverage for vehicle detection. It shall be possible to download detector configurations from the PC to the MVP sensor and cabinet interface module, to retrieve the detector configuration that is currently running in the MVP sensor, and to back up detector configurations by saving them to the PC fixed disks or other removable storage media.

## **REVISION OF SECTION 614 INTERSECTION DETECTION SYSTEM (CAMERA)**

The supervisor computer's mouse and keyboard shall be used to edit previously defined detector configurations to permit adjustment of the detection zone size and placement, to add detectors for additional traffic applications, or to reprogram the MVP sensor for different traffic applications or changes in installation site geometry or traffic rerouting.

**Optimal Detection:** The video detection system shall optimally detect vehicle passage and presence when the MVP sensor is mounted 30 feet (10 m) or higher above the roadway, when the image sensor is adjacent to the desired coverage area, and when the distance to the farthest detection zone locations are not greater than ten (10) times the mounting height of the MVP. The recommended deployment geometry for optimal detection also requires that there be an unobstructed view of each traveled lane where detection is required. Although optimal detection may be obtained when the MVP is mounted directly above the traveled lanes, the MVP shall not be required to be directly over the roadway. The MVP shall be able to view either approaching or receding traffic or both in the same field of view. The preferred MVP sensor orientation shall be to view approaching traffic since there are more high contrast features on vehicles as viewed from the front rather than the rear. The MVP sensor placed at a mounting height that minimizes vehicle image occlusion shall be able to simultaneously monitor a maximum of six (6) traffic lanes when mounted at the road-side or up to eight (8) traffic lanes when mounted in the center with four lanes on each side.

**Count Detection Performance:** Using an installed camera that meets the optimal viewing specifications described above for count station traffic applications, the system will be able to accurately count vehicles with at least 98% accuracy under normal operating conditions (day and night), and at least 93% accuracy under artifact conditions.

Artifact conditions are combinations of weather and lighting conditions that result from shadows, fog, rain, snow, etc. The volume count will be accumulated for the entire roadway (all traveled lanes), and accumulated over time intervals that contain a minimum of one hundred (100) vehicles to ensure statistical significance.

**Demand Presence Detection Performance:** Using an installed camera that meets the optimal viewing specifications described above for intersection control traffic applications, the system will be able to accurately provide demand presence detection.

The demand presence accuracy will be based on the ability to enable a protected turning movement on an intersection stop line, when a demand exists. The probability of not detecting a vehicle for demand presence will be less than 1% error under all operating conditions. In the presence of artifact conditions, the MVP will minimize extraneous (false) protected movement calls to less than 7%.

To ensure statistical significance, the demand presence accuracy and error will be calculated over time intervals that contain a minimum of one hundred, protected turning movements.

These performance specifications will be achieved with a minimum of 2 presence detectors coupled with a single detector function (Type-9) to provide adequate road coverage to sample the random arrival pattern of vehicles at the stop line.

The calculation of the demand presence error will not include turning movements where vehicles do not pass through the presence detectors, or where they stop short or stop beyond the combined detection zones.

## **REVISION OF SECTION 614 INTERSECTION DETECTION SYSTEM (CAMERA)**

Speed Detection Performance: The MVP will accurately measure average (arithmetic mean) speed of multiple vehicles with more than 97% accuracy under all operating conditions for approaching and receding traffic.

The average speed measurement will include a minimum of 100 vehicles in the sample to ensure statistical significance. Optimal speed detection performance requires the camera location to follow the specifications described above for count station traffic applications with the exception that the camera must be higher than 13 m (40) feet.

The MVP will accurately measure individual vehicle speeds with more than 94% accuracy under all operating conditions for vehicles approaching the camera (viewing the front end of vehicles), and more than 90% accuracy for vehicles receding from the camera (viewing the rear end of vehicles).

These specifications will apply to vehicles that travel through both the count and speed detector pair and will not include partial detection situations created by lane-changing maneuvers.

To ensure statistical significance, the average speed accuracy and error will be calculated over time intervals that contain a minimum of one hundred vehicles.

Using a MVP sensor installed within the optimal viewing specifications described above or count station traffic applications

### **Modular Cabinet Interface Unit:**

The modular cabinet interface unit shall provide the hardware and software means for up to eight (8) MVP sensors to communicate real-time detection states and alarms to a local traffic signal controller. It shall comply with the electrical and protocol specifications of the detector rack standards. The card shall have 1500 Vrms isolation between rack logic ground and street wiring.

The modular cabinet interface unit shall be a simple interface card that plugs directly into a 170 input file rack or a NEMA type C or D detector rack. The modular cabinet interface unit shall occupy only 2 slots of the detector rack. The modular cabinet interface unit shall accept up to sixteen (16) phase inputs and shall provide up to twenty-four (24) detector outputs.

### **Communications Interface Panel:**

The communications interface panel shall support up to eight MVPs. The communications interface panel shall accept 110/220 VAC, 50/60 Hz power and provide predefined wire termination blocks for MVP power connections, a Broadband-over-Power-Line (BPL) transceiver to support up to 10MB/s interdevice communications, electrical surge protectors to isolate the modular cabinet interface unit and MVP sensors, and an interface connector to cable directly to the modular cabinet interface unit.

The interface panel shall provide power for up to eight (8) MVP sensors, taking local line voltage 110/220 VAC, 50/60 Hz and producing 110/220 VAC, 50/60 Hz, at about 30 watts to each MVP sensor. Two ½-amp SLO-BLO fuses shall protect the communications interface panel.

**REVISION OF SECTION 614  
INTERSECTION DETECTION SYSTEM (CAMERA)**

**System Installation & Training:**

The supplier of the video detection system may supervise the installation and testing of the video detection system and computer equipment as required by the contracting agency. Training is available to personnel of the contracting agency in the operation, set up, and maintenance of the video detection system. The MVP sensor and its support hardware / software is a sophisticated leading-edge technology system. Proper instruction from certified instructors is recommended to ensure that the end user has complete competency in system operation. The User's Guide is not an adequate substitute for practical classroom training and formal certification by an approved agency.

**Warranty, Service, & Support:**

For a minimum of three (3) years, the supplier shall warrant the video detection system. An option for additional year(s) warranty for up to 6 years shall be available. Ongoing software support by the supplier shall include software updates of the MVP sensor, modular cabinet interface unit, and supervisor computer applications.

These updates shall be provided free of charge during the warranty period. The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be available to the contracting agency in the form of a separate agreement for continuing support.

**Subsection 614.13 shall include the following:**

Intersection Detection System (Camera) shall be measured and paid by the number of intersections at which the system is installed. The item shall include all labor, materials, and ancillary hardware required to provide a fully-functional system to the satisfaction of the Engineer.

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Intersection Detection System (Camera)	Each

**REVISION OF SECTION OF 614  
PEDESTRIAN PUSH BUTTON AND INSTRUCTION SIGN**

**Section 614 of the Standard Specification is hereby revised for this project as follows:**

**Subsection 614.08 (f) shall include the following:**

**1-1:** Push button assemblies shall be of the direct push button solid state contact type and shall not have any levers, handles or toggle switches externally or internally. The pushbutton shall be of tamperproof and all weather construction. The pushbutton shall have a protective shroud that is an integral part of the cover and it shall encircle the pushbutton actuator to deter vandalism. The assembly shall be made weatherproof and shockproof by means of synthetic rubber gaskets between the cover and the enclosure and between the plunger and the cover so that it shall be impossible to receive an electrical shock under any weather conditions. The front cover plate shall be secured with stainless steel vandal resistant screws. The push button shall operate on logic ground.

**1-2:** The solid state switch shall be entirely insulated from the housing and operating button. The pushbutton shall consist of a 2 inch 303 stainless steel metal plunger and an oil and gasoline resistant Piezo driven solid state switch, all encased in a high impact thermoplastic enclosure with four (4) stainless steel mounting screws. The solid state switch shall be normally open and shall be closed with a minimum of pressure on the button ( $3lb \pm 1lb$ ), restoring immediately to the normally open position when the pressure is released.

The aluminum housing shall be the flat back frame type with adjustable mounting staves that will readily enable it to be mounted on any size traffic signal pole or push button standard. The housing shall have a ½ inch access hole in the rear for wiring. The housing shall have a bottom threaded conduit entrance hole and shall be provided with a threaded plug so that access is only possible from the rear of the housing. The plug shall not be removable with ordinary tools. The housing shall be painted Dark Olive/Federal Green baked enamel matching to Federal Standard 595A color #14056.

The frame shall have a cast aluminum attachment to allow the mounting of a 9" X 12" pedestrian instruction sign. By removal of 4 screws the frame shall convert to allow the mounting of a 5" X 7 ¾" pedestrian instruction sign.

**Pedestrian Instruction Sign:**

**2-1:** Pedestrian instruction signs shall conform to the latest version of the M.U.T.C.D., published by the U.S. Department of Transportation Federal Highway Administration.

**2-2:** Pedestrian instruction signs shall be Type R10-3a, Type R10-3b, Type R10-3c, R10-3d, and R10-3e as specified in the contract documents (or bid documents).

Pedestrian instruction signs shall be constructed in accordance with the applicable provisions of the current CCD Standard Specifications. Pedestrian instruction sign need not be reflectorized.

The sign shall be fabricated with 0.063 aluminum. The signs shall be mounted using four 5/16" mounting holes 4" X 6 ¾" for the 5" X 7 ¾" sign and 7" X 10" for the 9" x 12" sign. The pedestrian instruction signs shall have rounded corners ¾" radius for the 5" X 7 ¾" sign and 1 ½" radius for the 9" X 12" sign.

**REVISION OF SECTION OF 614  
PEDESTRIAN PUSH BUTTON AND INSTRUCTION SIGN**

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Pedestrian push button instruction sign	Each

**REVISION OF SECTION 614  
LED PEDESTRIAN SIGNAL HEAD (COUNTDOWN)**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.01 shall include the following:**

This work includes the installation of LED Pedestrian Signal Faces with countdown timers as shown in the Contract.

**Subsection 614.08 (h) shall include the following:**

Pedestrian signal faces with countdown timers shall meet the following requirements:

- (1) The dimensions of the signal housing and the LED symbols, as well as moisture and dust resistance requirements shall be in accordance with the current ITE PTCSI Standards.
- (2) Signal housing shall be aluminum, painted in Federal Green and “clam-shell” mounted.
- (3) The signal shall have user-selectable modes for countdown for walk cycle only, pedestrian cycle only, or both walk and pedestrian clearance.
- (4) The countdown module shall have an internal conflict monitor to prevent any possible conflicts between the Hand/Person signal indications and the time display. The display shall not countdown during a Solid Hand indication.
- (5) LED symbols shall be solid icons and shall provide uniform light dispersion such that the “pixel” effect is minimized. Lettered or outline symbol styles will not be permitted.
- (6) The Man/Hand configuration shall provide clear and distinct lamination where either symbol is in use.
- (7) The LED module shall be rated for use in an ambient operating temperature range of -40° F to 165° F.
- (8) The signal shall meet NEMA Standard TS2 for voltage surge protection, and shall have an automatic reset in case of a power outage.

**Subsection 614.13 shall include the following:**

LED Pedestrian Signal Face (Countdown) will be measured by the actual number of units that are installed and accepted.

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Pedestrian Signal Face (16) (Countdown)	Each

**REVISION OF SECTION OF 614  
TRAFFIC CONTROL DEVICES**

**Section 614 of the Standard Specification is hereby revised for this project as follows:**

**Subsection 614.08 (h) shall include the following:**

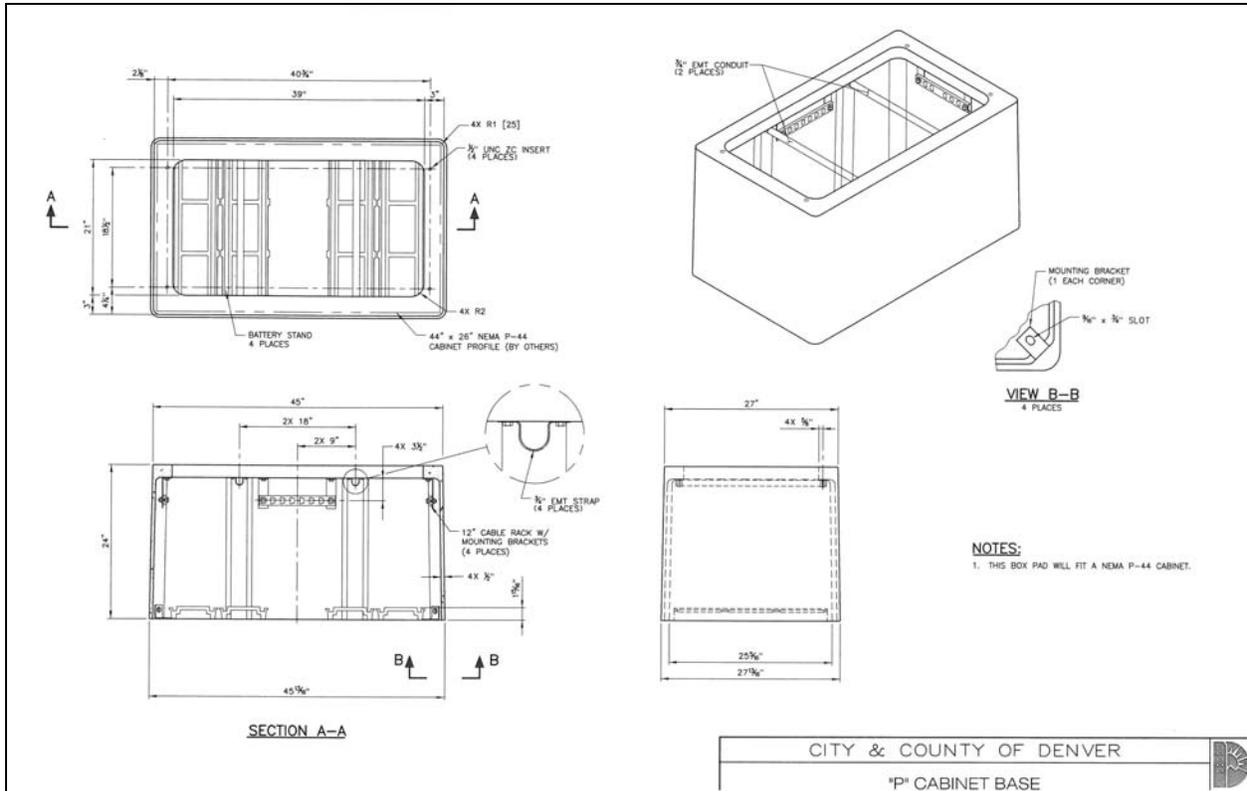
“Light Emitting Diode” (LED) signal lenses shall be installed in all Red, Yellow, Green, Walk and Don’t Walk, and Countdown signal displays. This work shall be included in the cost of the item for Traffic Signal Face and will not be paid for separately.

## REVISION OF SECTION 614 TRAFFIC SIGNAL CABINET BASE

Section 614 of the Standard Specifications is hereby revised for this project as follows:

**Subsection 614.01 shall include the following:**

This work consists of furnishing and installing a Quazite Traffic Signal Controller Cabinet Base as shown on the plans and in accordance with the City & County of Denver standards. The base shall fit the City and County of Denver's P-Type Traffic Signal Controller Cabinet. Dimensions of the base are shown in the following drawing.



**Subsection 614.10 shall include the following:**

Prior to starting cabinet base installation, the contractor shall obtain field verification of the location of the base from the Engineer or Engineer's designee.

Cabinet base installation shall include all labor and materials to completely install a new P-type cabinet base for the controller cabinet as specified in the plans. This is to include all conduit installation and modification work, back-filling, and repair to all surrounding surface/area.

**REVISION OF SECTION 614  
TRAFFIC SIGNAL CABINET BASE**

**Subsection 614.13 shall include the following:**

The traffic signal cabinet base and installation will not be measured and paid for separately, but shall be incidental to the Traffic Signal Controller and Cabinet installation.

**Subsection 614.14 shall include the following:**

Traffic signal cabinet base and installation will not be paid for separately, but shall be included in the cost of the Traffic Signal Controller and Cabinet installation.

**REVISION OF SECTION 614  
TRAFFIC SIGNAL CONTROLLER CABINET**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.01 shall include the following:**

This work shall consist of furnishing and installing a new P-type Traffic Controller Cabinet and complete installation of the Traffic Signal Controller Cabinet assembly, malfunction management units (MMU), vehicle detector amplifiers, uninterrupted power supply (UPS), other ancillary hardware, and traffic signal cabinet base per City and County of Denver standards.

**Delete Subsection 614.08 (c) and replace with the following:**

All new cabinets are the P-type cabinets as per the City & County of Denver Traffic Standards. Each cabinet shall be installed on a newly installed traffic signal controller cabinet base unless otherwise specified on the plan. Contact Chris Lillie at 720-865-0466 for cabinet assembly requirements and all other necessary auxiliary hardware.

Controller cabinet assemblies shall include an integrated uninterrupted power supply (UPS) units that comply with the City and County of Denver standards (see UPS spec).

**Subsection 614.10 shall include the following:**

The Contractor shall demonstrate successful traffic signal operations at all new controller and cabinet locations to the satisfaction of the Engineer or Engineer's designee prior to acceptance of this item. The Contractor shall contact the Engineer or Engineer's designee 3 days before turning on signal. Work shall include all required programming of controllers and establishing or re-establishing all required wiring connections. Phasing and timing information at each location shall be furnished to the Contractor by the City & County of Denver.

All new wiring shall conform to City & County of Denver and International Municipal Signal Association (IMSA) specifications.

**Subsection 614.13 shall include the following:**

The unit price for the installation of traffic signal controllers cabinets shall include all labor, materials, ancillary hardware, traffic signal cabinet base, wiring and wiring re-connection (including Xcel Energy power feed) required to provide successful operation of the item.

Removal and disposal of existing cabinets shall be in accordance with the Project Special Provision for the referenced item.

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Traffic Signal Controller and Cabinet	Each

**REVISION OF SECTION 614  
TRAFFIC SIGNAL CONTROLLER  
(SOLID STATE) (FULL-ACTUATED) (12 PHASE)**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Delete Subsection 614.08 (b), and replace with the following:**

**Traffic Signal Controllers – General**

This specification sets forth the minimum requirements for a shelf-mountable, two through twelve phases, fully-actuated, digital, solid-state traffic controller. The controller shall meet, as a minimum, all applicable sections of the NEMA Standards Publication No. TS2-1998. Where differences occur, this specification shall govern. Controller versions shall be available to comply with NEMA TS2"Types 1 and 2. Type 2 versions of the controller shall be capable of operating as a Type 1.

The controller shall meet or exceed the specifications of the Econolite model ASC/3-1000 Fully Actuated Controller ([http://www.econolite.com/docs/controller\\_asc3\\_specification.pdf](http://www.econolite.com/docs/controller_asc3_specification.pdf)), or an equivalent approved by the City and County of Denver Traffic Engineering Services.

**Subsection 614.09 shall include the following:**

The Contractor shall deliver the traffic signal controller, and cabinet assemblies and other auxiliary hardware, to the City and County of Denver Traffic Operations Center at 5440 Roslyn Street, Building E, Denver, Colorado 80216 six (6) weeks before installation for controller programming. The Contractor shall coordinate the pick-up of the controller and cabinet assembly from the City and County of Denver's Traffic Engineering Services and shall install it at the proper location. The Contractor shall coordinate pick-up times with Chris Lillie at (720) 865-4066.

The controller shall be installed in accordance with the details shown in the plans and in accordance with manufacturer's recommendations.

**Subsection 614.13 shall include the following:**

Traffic Signal Controller (Solid State) (Full Actuated) (12 phase) shall include pedestrian detectors and all auxiliary equipment required on the plans and shall include all work necessary to provide and install a complete system. Connection of the controller to the fiber optic interconnect system shall be paid for separately under item 614 "Telemetry (Field)".

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Traffic Signal Controller (Solid State) (Fully-Actuated) (12 Phase)	Each

## **REVISION OF SECTION 614 TRAFFIC SIGNAL POLES – GENERAL**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.08 (g) shall include the following:**

**Traffic Signal Poles:** All traffic signal poles and mast arms shall conform to City and County of Denver Standards and the local utility company's (Xcel Energy) requirements. The traffic signal pole standards are shown below:

All traffic signal poles shall include a 10 foot long luminaries mast arm and a 250 WATT high pressure sodium curvilinear style luminaries in accordance with the current City and County of Denver Standards. Prior to order of traffic signal poles, mast arms and luminaries, contractor shall submit material specifications to the City and County of Denver Traffic Engineering Services for approval.

**Painting:** All traffic signal mast arm poles and mast arms shall be powder coated in accordance with the following specifications:

**General:**

**Super Durable Powder Coating:** The super durable powder coating shall consist of a Urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder, and provide a minimum of 3 times the gloss retention, color retention and ultraviolet light (UV) resistance as standard powder coatings. Color shall be dark olive green, in conformance with Federal Specification No. 14056.

**Surface Preparation:**

The exterior steel surface shall be blast cleaned to Steel Structures Painting Council Surface Preparation Specification No. 6 (SSPC-SP6) requirements utilizing cast steel abrasives conforming to the Society of Automotive Engineers (SAE) Recommended Practice J827. The blast method is a recirculating, closed cycle centrifugal wheel system with abrasive conforming to SAE Shot Number S280.

The exterior and interior surfaces of the pole shafts shall be hot dip galvanized from the base end for a length of approximately 12.0'.

**Interior Color:**

Interior surfaces (pole shafts only) at the base end for a length of approximately 2.0' shall be mechanically cleaned and coated with a zinc rich epoxy powder. The coating shall be electrostatically applied and cured in a gas fired convection oven by heating the steel substrate to a minimum of 350 degrees Fahrenheit and a maximum of 400 degrees Fahrenheit.

**Exterior Coating:**

All exterior surfaces shall be coated with Urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils (0.002"). The coating shall be electrostatically applied and cured in a gas fired convection oven by heating the steel substrate to a minimum of 350 degrees Fahrenheit and a maximum of 400 degrees Fahrenheit. The thermosetting powder resin shall provide both intercoat as well as substrate fusion adhesion that meets 5A or 5B classifications of ASTM D3359.



# REVISION OF SECTION 614 TRAFFIC SIGNAL POLES – GENERAL

TABLE 2: POLE DATA																
POLE SERIES	DESIGN NUMBER	SINGLE ARM SPAN (FT)	DOUBLE MAST ARMS		POLE TUBE				POLE BASE				ANCHOR BOLT			
			1st ARM SPAN (FT)	2nd ARM SPAN (FT)	BASE O.D. (IN)	TOP O.D. (IN)	LENGTH (FT)	THICK (IN)	SQUARE (IN)	BOLT CIRCLE (IN)	THICK (IN)	POLE O.D. (IN)	DA (IN)	LENGTH (IN)	HOOK (IN)	THREAD LENGTH (IN)
DC01	1	20,25,30,35, & 40	N.A.	N.A.	15.50	10.60	35.00	.1875	21.00	20.00	1.75	2.00	1.75	84.00	6.00	8.00
DC01	2	45,50 & 55	N.A.	N.A.	17.00	12.10	35.00	.2188	23.00	22.00	2.00	2.25	2.00	84.00	6.00	10.00
DC01	3	60,65, & 70	N.A.	N.A.	19.50	14.60	35.00	.2500	26.00	25.00	2.00	2.25	2.00	84.00	6.00	10.00
DC01	4	N.A.	20 THRU 40	20 THRU 40	15.50	10.60	35.00	.2500	23.00	22.00	2.00	2.25	2.00	84.00	6.00	10.00

MAXIMUM ARM LENGTH COMBINATION FOR DUAL CONFIGURATION ARE 40'-0"/40'-0". ARM LENGTHS EXCEEDING THESE WILL REQUIRE A SPECIAL POLE DESIGN.

TABLE 3: SIGNAL ARM DATA									
SIGNAL ARM TUBE				SIGNAL ARM SIMPLEX					
MAXIMUM ARM SPAN (FT)	FIXED END DIA. (IN)	SMALL END DIA. (IN)	GAUGE	A X B (IN)	C X D (IN)	THICKNESS "t" (IN)	BOLT SIZE "T" (IN)	DISSET THICKNESS (IN)	ANGLE OF RISE IN ARM
20.00	9.00	6.20	7	21.75 X 21.75	18.00 X 18.00	1.75	1.50 X 3.75	.375	0.00°
25.00	10.00	6.50	7	21.75 X 21.75	18.00 X 18.00	1.75	1.50 X 3.75	.375	0.50°
30.00	12.00	7.80	5	21.75 X 21.75	18.00 X 18.00	1.75	1.50 X 3.75	.375	0.50°
35.00	12.50	7.60	5	21.75 X 21.75	18.00 X 18.00	1.75	1.50 X 3.75	.375	1.00°
40.00	13.00	6.90	3	21.75 X 21.75	18.00 X 18.00	1.75	1.50 X 3.75	.375	1.50°
45.00	14.00	8.06	SEE DETAIL 10	23.25 X 23.25	19.50 X 19.50	2.00	1.50 X 4.25	.500	1.50°
50.00	15.00	8.36	SEE DETAIL 10	23.25 X 23.25	19.50 X 19.50	2.00	1.50 X 4.25	.500	1.50°
55.00	15.00	7.66	SEE DETAIL 10	23.25 X 23.25	19.50 X 19.50	2.00	1.50 X 4.25	.500	2.00°
60.00	15.75	7.71	SEE DETAIL 10	26.25 X 26.25	22.50 X 22.50	2.00	1.50 X 4.25	.500	2.00°
65.00	16.50	7.76	SEE DETAIL 10	26.25 X 26.25	22.50 X 22.50	2.00	1.50 X 4.25	.500	2.00°
70.00	17.25	7.81	SEE DETAIL 10	26.25 X 26.25	22.50 X 22.50	2.00	1.50 X 4.25	.500	2.50°

CITY & COUNTY OF DENVER

PUBLIC WORKS  
STD DWG NO

TABLE DATA

3

MATERIAL DATA									
COMPONENT	ARM DESIGNATION	ARM DIA. (IN)	ARM LENGTH (FT)	ARM WEIGHT (LBS)	COMPONENT	ARM DESIGNATION	ARM DIA. (IN)	ARM LENGTH (FT)	ARM WEIGHT (LBS)
POLE SHAFT	ASIS OR A	55	20.00	11.36	ANCHOR BOLT	A	1/2	8.00	30
ARM SHAFT	ASIS OR A	55	10.00	5.68	ANCHOR BOLT	B	1/2	8.00	30
POLE BASE	ASIS	36	10.00	1.36	ANCHOR BOLTS	P1584	3/8	10.00	35

TABLE 2: POLE DATA															
CITY	POLE SERIES	DESIGN NUMBER	SINGLE ARM SPAN (FT)	POLE TUBE		POLE BASE				ANCHOR BOLT					
				BASE O.D. (IN)	TOP O.D. (IN)	LENGTH (FT)	THICK (IN)	SQUARE (IN)	BOLT CIRCLE (IN)	THICK (IN)	POLE O.D. (IN)	DA (IN)	LENGTH (IN)		
DC01	5		8.75	3.85	35.00	1793	12.00	12.50	1.25	1.25	1.25	42.00	6.00	7.00	6.00

CITY & COUNTY OF DENVER

PUBLIC WORKS  
STD DWG NO

LUMINAIRE DETAILS

4

**REVISION OF SECTION 614  
TRAFFIC SIGNAL POLES – GENERAL**

**Packaging:**

Prior to shipment, small poles shall be wrapped in 0.188” thick Ultraviolet inhibiting plastic backed foam. Larger poles shall be cradled in a 1.0” rubberized foam base.

**Handling and Shipment:**

Poles shall be handled in a manner that will preserve the overall appearance and prevent damage to the coating. The use of chains or cables for loading, unloading, or installing is prohibited. Only ¾ inch diameter or larger nonabrasive nylon rope or equivalent nylon belting will be used. Adequate hold-downs and appropriate blocking shall be utilized for shipping to prevent load movement and damage to the outer coating in transit. No handling should be allowed until “dry through” condition has been achieved with the coating.

**Delivery, Installation, and Acceptance of Poles:**

Extra care will be taken not to damage the coating. Upon arrival of the poles at the delivery point, neither chains nor cables will be used to either unloading or installation of poles.

**Procedure for Field Touch-Up:**

The pole manufacturer will furnish extra paint, both primer and color coat, to satisfy the needs of field touch-up requirements, in the event of minor physical damage to the coating from handling or transit. Damaged area must be clean and dry before repair application. Field touch-up will be at the direction of the pole manufacturer or their authorized representative.

**Subsection 614.14 shall include the following:**

<b>Pay Item</b>	<b>Pay Unit</b>
Traffic Signal Pole and Mast Arm (Steel) (XX Foot Mast Arm)	Each

**REVISION OF SECTION 614  
DOUBLE CONVERSION UNINTERRUPTED POWER SUPPLY SYSTEM**

**Section 614 of the Standard Specifications is hereby revised for this project as follows:**

**Subsection 614.08 shall include the following:**

The double conversion uninterruptible power supply system (UPS) shall provide emergency battery power to the traffic signal controller. The work consists of furnishing and installing an UPS in accordance with the City and County of Denver's standards and shall conform to the following specifications:

**Operation:**

The UPS system shall be capable of producing a fully regenerated, conditioned, pure sine wave AC. The online operational mode shall be continuous to all loads. It shall incorporate a high frequency Pulse-Width Modulated technology and shall use an input rectifier, charger, battery and inverter in a single board configuration. The UPS double conversion UPS shall provide a clean, pure AC sine-wave output at all times with a voltage input variation of 85VAC to 145VAC while providing 120VAC to the connected load at all times. The UPS shall be capable of operating in the voltage range of 85VAC to 135VAC without using the batteries and always provide a regulated output to the protected loads.

The Input rectifier shall be rated at 2.5 times the output rating of the inverter.

The Inverter circuit shall be in continuous operation at all times (constant duty). The inverter shall be rated for 100% duty cycle and simultaneously fed from the rectifier and battery to eliminate any switching to battery or transitions during power fluctuations or power interruption. The inverter's output shall be pure clean sine wave with an efficiency of up to 85%.

The constant duty operation shall be rated in total watts. This will enable the traffic UPS to support any combination of signal heads whether Incandescent, LED or Neon, by any manufacturer, regardless of power-factor.

The UPS shall be capable of operating from a generator source without the need for over-sizing the UPS system. During operation from a generator source, the UPS shall operate in a normal fashion and provide filtered and regulated power with or without automatic input/output frequency synchronization. Upon excessive generator frequency drift, the UPS shall compensate through regeneration and supplying both continuous frequency and voltage regulation to the protected load.

The UPS shall be capable of glitch ride through capabilities and provide a seamless output to the connected load during this anomaly without the use of the batteries.

The UPS shall be capable of providing an overload output rating of 120% for 60 seconds, 150% for 10 seconds to any combinations of signal types whether Incandescent, LED or Neon during inrush or overload conditions.

The UPS shall have an internal static bypass that will transfer to line power if over load exceeds 150% for more than 5 sec. This bypass will maintain the load until this overload has cleared.

The UPS shall have a separate Neutral detecting circuit that shall monitor loss of utility neutral and completely disconnect any input source to the UPS system.

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The UPS shall have an input back feed relay operating in series with the Neutral monitoring circuit.

Upon loss of utility power, the UPS inverter shall continue to provide seamless pure sine-wave AC from the batteries without switching, transfer or changing its' operating status. The UPS will use the battery mode in '0' ms. This will insure that the UPS provides pure sine wave power under all conditions, at all times without interruption.

The UPS will continue to provide generated AC from the inverter until the batteries are depleted.

When the batteries have been depleted, the UPS will ensure upon the return of Utility Power that the UPS will restart automatically and provide regenerated AC to the protected equipment and allow the equipment to resume normal operation.

The UPS shall be capable of operating in a full regenerated, power-conditioning mode with depleted batteries or failed batteries. The regenerative power conditioning will ensure that there will be regulated and conditioned pure AC power to the equipment. This regenerative mode will provide extended brown-output protection with wide input line regulation, noise filtering and surge protection.

The UPS shall operate in an uninterruptible regenerative on-line mode during flash or normal signal operation.

The UPS shall be rated at Unity Power Factor. The output VA and Watts rating shall be equal on the output at all times.

The UPS shall be capable of COLD starting without AC present and provide AC power to the load.

The UPS shall be capable of self diagnostics during start up or with the use of the front panel TEST button.

The UPS case shall be constructed from .064 aluminum and carbon steel.

The UPS input and output connections shall be Anderson Power Pole quick lock connector to eliminate exposed terminals or connections.

The UPS to bypass interconnect harness shall be reversible with matching Anderson Power connectors that will prevent risk of shock, or damage to the connected equipment.

The UPS shall be capable of Hot-Swapping the batteries or battery bank, without shutting down the UPS.

The UPS shall be capable of being Hot-Swapped during normal operation when used with the external Hot Swap Bypass. The UPS may also be shut-off with the Hot Swap Bypass in place without loss of AC to the loads.

The UPS shall be capable of providing a replaceable relay card with relay output contacts for AC fail, Inverter ON, Low Battery, Battery Fail, Bypass and Alarms.

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The UPS relay card may be replaced with an SNMP card for SNMP communications and information.

The UPS shall provide a programmable Dry Relay output for flash.

The contacts shall be provided in N/O and N/C positions. The delay timer shall be a maximum of 10 hours.

The timer shall be front panel mounted.

The Timer dial shall be 4.7 inches in circumference.

The timer shall have a scale in increments of 1s to 10seconds. This scale can be changed to indicate 1 minute, to 10 minutes or a maximum scale of 1 hour to 10 hours.

The scale shall be controlled by two (2) separate dip switches on the timer face.

The timer shall indicate using a flashing RED LED that the timing function is operating.

The timer shall use a steady RED LED to indicate that the timing is now completed

The timer shall count in a down mode to '0' from the preset time indicated on the scale.

The LED indicators shall provide status for AC line, UPS Battery Mode, Charging, Low Battery, Fault, Bypass, Percentage of Load and Battery Charge.

The Event counter and Hour meter may be reset to '0' using separated buttons.

The UPS shall have a battery charger rated at 200 watts @ 36VDC with an optional of 400 watts.

This charger shall be completely separate from the rectifier/inverter included with the main UPS board.

The UPS chargers may be used in a parallel configuration for increased charger ratings.

The UPS uses a redundant internal 1 amp charger that will continue to charge the batteries if the separate board charger fails.

The UPS may be used with redundancy in mind with the use of the Dual Hot Swap Option.

That will provide a secondary UPS source in less than 20ms. The Secondary UPS may be connected to the alternate input of the Hot Swap Bypass

The Flash programming shall be a simple and field programmable without the use of an external connected device such as a laptop or computer.

The Hot swap Bypass shall allow the UPS to be removed or installed at any time during normal load operation.

The UPS shall include standard graphical real time software and connection cable.

The UPS shall be capable of sending programmable system alarms to the Econolite "icons" Traffic Management System.

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### **Physical Description:**

The UPS shall consist of 3 major components. The Main board Rectifier/Inverter, charger and control board.

The Main Board shall consist of a True-Sine-Wave constant duty high frequency inverter utilizing High-Frequency Pulse-Width Modulated technology.

The Input Rectifier shall be rated for the total wattage output rating of the UPS including the 150% overload and the charger rating. The inverter shall be a high efficiency constant duty design with an efficiency of 83%. The inverter shall include its' own static bypass which provides an alternate AC path during overload and or Inverter alarm conditions.

The heat-sink shall be a continuous aluminum extrusion design with plenum directed airflow cooling. The 12VDC dual stage cooling fans shall be variable speed controlled by the logic board.

The charger portion shall be a 3 stage Hysterisis .5 amp, 36 or 72VDC charger with temperature compensation. The supplementary charger, is a parallel design rated for 200, 500 and 1000 watts.

The Electronic Control board shall monitor the Rectifier and Inverter functions. It shall also provide the overall control of all the UPS functions and or operational capabilities.

### **Mounting Configuration:**

The UPS shall be shelf mounted or rack mounted per the documents. Shelves and cabinets shall be supplied by others. Where rack mounting is required, the 170 style mounting method shall be 19" rack mount. Rack mounting ears shall be removable.

A separate stand alone NEMA Traffic cabinet may be supplied if required in the plans and specifications.

4 rubber feet shall be installed on the bottom of the unit for shelf mounting.

### **Battery System:**

The batteries shall be comprised of a quantity of three (3), high temperature, deep cycle (45AH ) batteries which have been proven under extreme temperature conditions. The battery system or configuration shall consist of one string. Each string shall be 36 VDC. The batteries shall be provided with the appropriate interconnect cables. The battery cables shall have a minimum conductor size rating of #10.

The battery cable shall consist of a quick release Anderson connector rated at 25 amps. For the purpose of safety, the connector shall have recessed pins and keyed interlock to prevent reversal of connection or separation.

Battery construction shall be of a polycarbonate high temperature design combined with high, pure lead content with internal resistance of .0028 ohms and a high impact poly case construction, to withstand high vibration and shock. The connections shall be of stainless steel 3/8 stud, with 3/8 stainless nut and locking washer. Removable lifting handle shall be standard.

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The batteries shall also meet the following characteristics:

Nominal voltage:	12VDC
Capacity@ 25C:	45AH
Approx weight:	13.5Kg
Internal Resistance:	9.5 mOhms
Dimensions:	197mm x 165mm x 170mm ( 7.76 x 6.50 x 6.69)
Capacity (10hr rate):	75c-112% 65c-108% 55c-105% 25c-100% 0c- 85% -15c- 65%
Self Discharge:	3 months 91% capacity remaining 6 months 82% capacity remaining 12 months 65% capacity remaining
Operating Temperature:	-15c to +75C
Float Voltage:	13.5 to 13.80
Cyclic charging voltage:	14.5 to 14.90
Maximum charge current:	12A
Terminal material:	Copper
Maximum discharge current:	400A (5 sec)

The system must be 36 volt DC maximum (no exception).

Electrical Specifications:

The unit shall meet the following electrical specifications:

Design:	Double Conversion true on line.
Nominal input:	110, 115 & 120v AC single phase dip switch selectable.
Input Voltage Range:	80v to 140v AC
Input frequency:	50/60hz (47 to 63)
Efficiency:	83 %
Input configuration:	3 wire with ground
Input Protection:	15 amp re-settable breaker ( on UPS 700)
Input Current:	10.4 amps (includes charger) ( on UPS 700)
Power Rating Continuous:	700 watts, 1400watts, 2100 watts
Output Current:	@ 700 watts 5.8 amps / 11.6 @1400/ 17.7@2100
Output regulation:	+/- 3% with 100% resistive load
Output regulation w/low battery:	+/- 3% with 100% resistive load
Output Voltage:	120v AC
Output Wave Form:	Pure sine wave
Harmonic Distortion:	3% Linear Load; 5% Non Linear Load

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Dynamic Response:	+/- 5% RMS for 100% step load change 1 ms recovery time
Overload Capability:	120% for 60 sec 150% watts for 10 sec
Charger:	200 watt 36VDC UPS 700, 72VDC on UPS 1400 Parallel 400, 1000 and 2000 watt.
Surge:	ANSI-C62.41
Fault Clearing:	Current Limit and automatic to bypass
Short Circuit protection:	Output Breaker / Fuse, then shut down
Load Power Factor:	6 leading to .6 lagging
Output Connection:	Anderson Power Pole Connector 6 pin keyed.
DC Connection:	Anderson 50 amp Keyed Recessed connector
Recognition:	UL Recognized & IEE 587 / C62.41 on main UPS board

**Mechanical:**

The UPS shall meet the following physical dimensions:

For 700 W UPS:

Size:	6.00" H x 10.5" D x 15.15" W
Weight:	18 lbs

The enclosure shall be constructed of 0.064 Carbon steel and aluminum. The enclosure shall be painted with powder coat paint with a minimum of 1.5 mil thickness.

**Environmental:**

The UPS shall meet or exceed NEMA temperature standards from -40c to + 74c.

**Communications, Control & Diagnostics**

LED indicators shall be provided for line monitoring, battery mode, charging, low battery, fault / bypass load level, battery level and ground fault. Manual test functions shall be available for alarm function, low battery, battery fail, bypass and overload. An RS 232 port with communication software shall be provided for real time UPS operational status in place of a relay status card when required.

The relay status card shall have the following I/O via contact closure:

1. Bypass ON
2. AC fail or out of tolerance.
3. AC normal or in tolerance.
4. Inverter is operating (ON)
5. Battery low
6. Battery failed or bad
7. UPS general alarm
8. Ground (logic)
9. Apply 6 to +25VDC
10. between pin 9 and 10, will shut the UPS down

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#### **Options:**

The UPS must be able to accept the following future options

- SNMP/WEB monitoring.
- 24/7 Adjustable perpetual timer.
- Generator input option for hot swap bypass switch.
- Rack mount hot swap bypass switch.

In place of the relay card, an SNMP card can be installed that shall support TCP/IP, UDP, SNMP, and HTTP protocols and shall provide the SNMP MIB for UPS monitoring and UPS status.

Remote access to UPS real time information including unit identification, data logging and UPS status in real time shall also be provided on a by unit basis. It shall be possible to use Microsoft Internet Explorer for remote viewing of the following:

1. UPS load
2. Battery Charger status
3. UPS operation Normal/Alarm
4. Input Voltage
5. Output Voltage
6. Battery Voltage
7. UPS Temperature
8. UPS information logging
9. Remote UPS battery testing.
10. Send output email if UPS status has changed
11. Built in reset with panel mounted led indicators for SNMP status.

The SNMP card shall have the following status LEDs:

- |        |  |
|--------|--|
| LED(1) | Green LED: Status receiving<br>Yellow: Data Transmitting |
| LED(2) | Green: SNMP connecting<br>Yellow: SNM P functioning      |

The optional 24/7 timer shall be integral to the UPS. It shall include a DB9 connector to provide the connection and programming to the timer. This timer shall be programmable for any number of flash delays related to the time of day. It allows the complete flexibility of flash delay or skipping the flash during that particular event related to traffic flow and even holidays. The time shall have the follow features:

1. 7 days, 24 hrs Flash delay timing.
2. Perpetual Clock.
3. Maximum of 31 setting per day.
4. Timing resolution to the minute.
5. 4 Possible commands per event.
6. Real-time operation, editing functions will not interrupt the unit's functions.
7. J-Tag port for instant preload of complete 7-day schedule file.
8. SPDT 10 amp 240VAC /24VDC ratings.
9. Input Voltage 110 to 240VAC or 24VDC unregulated supply.
10. Plus! Capable of scheduling for holidays or specific year/dates.
11. Capable of operating at 2400 baud micro-modem for direct phone connection
12. Capable of operating at 1200 to 230,000 baud rate on a serial port.
13. Capable of log retention

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An optional generator input shall be available for the UPS.

**Reliability:**

Calculated MTBF shall be 120,000 hours based on component ratings. When bypass switch is installed, system MTBF shall increase to 160,000 hours.

**Hot Swap Bypass Switch:**

A hot bypass switch shall be provided and wired to function within the UPS system. The bypass switch shall have the following characteristics:

Bypass Rating:	30 amps maximum
Bypass Transfer:	Automatically to line in 20ms, '0' crossing at full load
Control:	Rocker On/Off switch indicating 'Auto' and Bypass
Relays:	AC internal Load relay at 'Zero Crossing' with parallel function DC relay for interlocking and protection failsafe mode to N/C for AC power direct to load when failure occurs or in Bypass position.
Protection:	Internal Snubber circuit for spike attenuation during transfer at 'Zero' crossing. Internal fuse required.
Connections:	Flush mounted Anderson Power connector. With locked and keyed.
Indicators:	LED for Line Available, Bypass, Ups On Line, UPS Available.
Dimensions:	7.5 x 5 x 2.5
Weight:	1.4 lbs

**Warranty:**

A standard (2) two year manufacturer warranty shall be provided for all electronic components. All batteries shall carry a one year warranty.

**Subsection 614.13 shall include the following:**

Emergency Vehicle Traffic Signal Priority Control System units shall include a four-channel card and the number of detectors as shown on the plans. Emergency Vehicle Traffic Signal Priority Control System shall be measured and paid by the number of intersections at which the system is installed. The item shall include all labor, materials, and ancillary hardware required to provide a fully functioning system to the satisfaction of the Engineer.

**Subsection 614.14 shall include the following:**

Traffic signal double conversion uninterrupted power supply system and installation will not be measured and paid for separately, but shall be included in the cost of the Traffic Signal Controller and Cabinet.