

# TRAFFIC SIGNAL STANDARD SPECIFICATIONS

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## CITY OF PHOENIX TRAFFIC SIGNAL STANDARD SPECIFICATIONS

### SECTION 470

#### GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND INTERSECTION LIGHTING SYSTEMS

##### **470.1 DESCRIPTION:**

The purpose of this section to provide general information necessary for completion of the installation of traffic signals, High Intensity Activated Crosswalk (HAWK) Pedestrian Beacon systems, Circular Rapid Flashing Beacon (CRFB) systems and intersection lighting in accordance with the details shown on the approved traffic signal plan, requirements of these specifications, and City of Phoenix Specifications for Public Works Construction, latest version; which is a combination of the Phoenix Supplement to the MAG Specifications in concert with the MAG Specifications and the latest version of the COP Traffic Signal Standard Details (<https://www.phoenix.gov/streets/reference-material>). All electrical systems and appurtenances shall be complete, functional and in operating condition at the time of acceptance.

##### **470.2 DEFINITIONS:**

The words defined in the following section shall for the purpose of these specifications have the meanings ascribed to them pertaining to signals and lighting.

**470.2.1 Actuation:** The operation of any type of controller initiated by a detector.

**470.2.2 Back Plate:** A thin metal strip extending outward parallel to the signal face on all sides of a signal housing to provide suitable background for the signal indications.

**470.2.3 Controller:** That part of the controller assembly, which performs the basic timing and logic functions for the operation of the traffic signal.

**470.2.4 Controller Assembly:** The complete assembly for controlling the operation of a traffic signal, consisting of a controller unit, and all auxiliary and external equipment housed in a weatherproof cabinet.

**470.2.5 Coordinated Traffic Signal System:** A group of signals timed together to provide a specific relationship among signal phases.

**470.2.6 Cycle:** A complete sequence of signal indications.

**470.2.7 Detector:** A device for indicating the passage or presence of vehicles or pedestrians.

**470.2.7.1 Inductive Loop Detector:** A detector capable of sensing the passage or presence of a vehicle (or bicycle for loop placed in an exclusive bike lane) by a change in the inductance characteristics of the wire loop.



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**470.2.7.2 Pedestrian Detector (Pedestrian Push Button):** A detector for pedestrians, usually of the push button type.

**470.2.7.3 Accessible Pedestrian Signal Detector (APS Push Button):** A pedestrian detector that has added capabilities to meet the requirements of the MUTCD Section 4E.

**470.2.7.4 Video Detector:** Video camera capable of detecting the presence or passage of vehicles or pedestrians.

**470.2.7.5 Other Detector:** A combination of a sensor and system processor capable of detecting the presence or passage of vehicles, bicycles, or pedestrians. Examples of such detection systems include, but are not limited to, a wireless embedded detector in pavement, infrared camera images, radar detection, or other detection devices used in concert with system processors.

**470.2.8 Emergency Vehicle Preemption:** Device(s) used to change the traffic signals and give priority to emergency fire trucks or ambulances during emergency dispatch.

**470.2.9 Flasher:** A device used to open and close signal circuits at a repetitive rate.

**470.2.10 Flashing Feature:** This feature, when operated, discontinues normal signal operation and causes a predetermined combination of flashing signal lights.

**470.2.11 Interval:** The part or parts of the signal cycle during which signal indications do not change.

**470.2.12 Luminaire:** The assembly, which houses the light source and controls the light emitted from the light source. Luminaires consist of a housing, lamp socket, reflector, lamp, photocell, and glass globe or refractor when specified.

**470.2.13 Manual Operation:** The operation of a signal controller unit by means of a hand-operated switch.

**470.2.14 Mounting Assembly:** The framework and hardware required to mount the signal face(s) and pedestrian signal(s) to the pole.

**470.2.15 Pedestrian Signal:** A traffic control signal for the exclusive purpose of directing pedestrian traffic at signalized locations.

**470.2.16 Pre-timed Controller Assembly:** A controller assembly for operating traffic signals in accordance with a predetermined fixed-time cycle.





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**470.2.17 Red Clearance Interval:** A clearance interval, which follows the yellow, change interval displaying a red indication to both the terminating phase and all conflicting phases prior to display of green for the next right-of-way phase.

**470.2.18 Signal Face:** An assembly controlling traffic in a single direction and consisting of one or more signal sections. Circular and arrow indications may be included in a signal assembly. The signal face assembly shall include back plate and visors.

**470.2.19 Signal Indication:** The illumination of a signal section or other device, or of a combination of sections or other devices at the same time.

**470.2.20 Signal Section:** A complete unit for providing a signal indication, consisting of a housing, lens, reflector, lamp receptacle and lamp, or LED unit.

**470.2.21 Traffic Phase:** A part of the time cycle allotted to any traffic movement or combination of movements receiving the right-of-way during one or more intervals.

**470.2.22 Traffic-Actuated Controller Assembly:** A controller assembly for operating traffic signals in accordance with the varying demands of traffic as registered with the controller unit by detectors.

**470.2.23 Vehicle:** Any motor vehicle normally licensed for highway use.

**470.2.24 Yellow Change Interval:** The first interval following the green right-of-way interval in which the signal indication for the phase is yellow.

### **470.3 REGULATIONS AND CODES:**

All electrical equipment shall conform to the current standards of the National Electrical Manufacturers Association (NEMA), the National Electric Safety Code (NESC), and Underwriters' Laboratory Inc. (UL), when applicable. All material and workmanship shall conform to the requirements of the National Electric Code (NEC), Illumination Engineers Society (IES), Standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the approved traffic signal plan, these specifications, the special provisions, and to any other codes, standards, or ordinances which may apply. Whenever references are made to any of the standards mentioned, the reference shall be interpreted to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement.

### **470.4 SOURCE OF SUPPLY:**

The contractor shall furnish all traffic signal material and equipment required to complete the work, except as noted on the foundation sheet of the approved traffic signal plan.



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**470.4.1 Quality Requirements:** Only materials and equipment conforming to the requirements of these specifications shall be incorporated into the work. Material and equipment shall be new except as may be provided in the special provisions.

City of Phoenix reserves the right to reject proposed traffic signal material or equipment if, in the judgment of the Engineer or designee, any or all the following may apply:

- 1) The equipment does not meet the requirements of the specifications.
- 2) The material or equipment's past field performance has been unsatisfactory.

In addition, City of Phoenix reserves the right to pre-approve traffic signal material and equipment by brand name model or part number which in the judgment of the Engineer or designee meets the intended purpose of these specifications.

Deviations from the pre-approved materials list, if any, will be listed in the project special provisions or construction plans.

**470.4.2 Approval of Material and Equipment:** All traffic signal materials and equipment shall be approved by the Engineer or designee prior to incorporation in the work. Any work in which materials or equipment not previously approved are used shall be performed at the contractor's risk and may be considered as unauthorized and unacceptable and not subject to the payment provisions of the contract. Such materials or equipment may be subject to removal at the discretion of the Engineer or the designee.

The contractor shall obtain the Engineer's or designee's approval before ordering or installing any material or equipment. The contractor shall submit three (3) copies of each proposed material and/or equipment list, including shop drawings. Each set shall include a three-ring binder with section tabs separating the documentation for each major item being submitted. Submittal shall be to the City prior to or at the pre-construction conference. Allow two (2) weeks for the City to review the submitted documentation for each submittal. To be acceptable, the list shall be complete and comprehensive containing all items to be supplied on the project by the contractor, including pre-approved items. COP reserves the right to reject any incomplete or unclear material submittal. All items on the list shall be identified by manufacturer's part number, model, accessories, specification, or other pertinent catalogue information. The materials from any catalog cuts shall be clearly indicated by the contractor. If standard manufacturer documentation does not specifically address all the product requirements that are required, then the contractor shall obtain a letter from the manufacturer certifying compliance with each referenced requirement that is not indicated on the standard documentation. One (1) copy will be returned to the contractor for further action.

All equipment or material specified or shown on approved signal plans, or other drawings, by



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brand name, part number, or model number is intended to be descriptive of the type and quality of material or equipment desired. Another equal brand name, part number, or model number may be substituted so long as it is in accordance with these specifications and is equal in form, fit, function, performance, reliability, and is approved by the Engineer.

The contractor shall provide complete wiring diagrams for controller assemblies and auxiliary controller cabinets at the time of delivery for testing. Four (4) sets of prints shall be provided with each controller assembly. The wiring diagram shall illustrate all circuits and components in detail. All components shall be identified by name or number to be clearly noted in the drawings.

Final approval, in writing by the COP Traffic Signal Engineer or designee, on all items within the submitted documentation is required to be obtained by the contractor.

It is the contractor's responsibility to ensure adequate lead time in ordering signal equipment to prevent project delays. The contractor shall notify the Engineer or designee in the event signal equipment is not received in a timely manner.

**470.4.3 Warranties and Guaranties:** In addition to the requirements of Section 108.8 (City of Phoenix Specifications for Public Works Construction), the following is required by the City of Phoenix for traffic signal related items. The warranty period will begin the day the work of this section is accepted by the City of Phoenix. Submit all manufacturer warranties to the City of Phoenix prior to installation. Expiration of the contractor's warranty under this section does not relieve the manufacturer should the manufacturer's warranties exceed that of the contractor. The warranty period for the following items is extended beyond the MAG Specification Section 108.8 one-year requirement as noted herein.

**470.4.3.1 LED Indications** Warrant all LED indication modules furnished by the contractor for five years following commencement of the warranty period against manufacturing and installation defects.

**470.4.3.2 Pedestrian Signal Heads** Warrant the entire pedestrian signal head assemblies, including the housing, doorframe, and visor for two years from the date of acceptance by the COP against defects in workmanship and/or material.

**470.4.3.3 Traffic Signal Heads** Warrant the entire traffic signal head assembly, including the housing, doorframe, and visor for two years from the date of acceptance by the COP against defects in workmanship and/or material.

**470.4.3.4 Detectors** Warrant all detectors, including loops, video detection cameras, pedestrian buttons and APS pushbuttons for two years from the date of acceptance by the COP against defects in workmanship and/or material.

### **470.5 CITY OF PHOENIX FURNISHED MATERIAL AND EQUIPMENT:**

Traffic signal material and equipment furnished by City of Phoenix or tested by City of Phoenix that is to be installed by the contractor will be made available at the following address:



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City of Phoenix Traffic Signal Shop  
2141 E. Jefferson St.  
Phoenix, Arizona 85034

The contractor shall contact the City of Phoenix Traffic Signal Supervisor at (602) 228-2578 five working days prior to desired pick-up date to confirm the item list, availability, date and time. Warehouse hours for pick-up and delivery are 8:30 am – 2:00 pm Monday through Friday.

The cost of handling and placing all material and equipment, including pick-up by the contractor is included in the contract price of the associated pay item. The contractor using the contractor's equipment shall load the furnished materials (poles, mast arms, etc.) onto the contractor's vehicle for transportation to the project site. COP personnel shall not load the materials. The contractor shall be responsible for any damage that occurs during the loading process.

The contractor will be held responsible for all material and equipment received. The Traffic Signal Supervisor or designee will issue a receipt for the materials provided. All materials will be issued in serviceable condition; the contractor will note any exceptions on the receipt. The receipt will be placed in the project file and a copy given to the contractor. The cost to make good any shortages or deficiencies, from any cause whatsoever and for any damage which may occur after receipt will be deducted from any monies due or becoming due to the contractor.

### **470.6 INSTALLATION OF TRAFFIC SIGNALS AND RELATED ITEMS:**

**470.6.1 General:** The contractor shall furnish labor and supervision with experience in the construction of the traffic signals and all materials, equipment, tools, transportation, and supplies required to complete the work in an acceptable manner; within the time specified, and in full compliance to these specifications, terms of the contract, the approved traffic signal plan and COP Traffic Signal Standard Details.

The contractor shall have a competent supervisor capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the construction of traffic signals assigned to the project. The contractor's supervisor shall possess a current International Municipal Signal Association (IMSA) Level II Traffic Signal Electrician/Technician Certification. The contractor shall have a complete set of construction drawings, including current COP Traffic Signal Standard Details, on site at all times during signal & lighting systems construction.

A level II IMSA certified technician/electrician must be on each work site at all times while work is being performed on traffic signals and other traffic control systems installed within the City of Phoenix.

Conductor splices and terminations may only be made by a qualified Journeyman Electrician, who has successfully completed a recognized four (4) year electrical apprenticeship program or equivalent training, or by a person enrolled in a recognized four (4) year electrical apprenticeship program, while under the direct supervision of a journeyman electrician



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**470.6.2 Traffic Signal Plan:** The approved traffic signal plan graphically describes the location of signal component parts, the equipment and materials to be used, and the standards for construction. The plans shall be supplemented by COP Traffic Signal Standard Details or other drawing(s) deemed necessary for the acceptable completion of the work.

After completion of the project, the contractor shall provide the Engineer with a set of as-built drawings on clean prints of the original drawings. The as-built drawing shall indicate in a neat and accurate manner all changes and revisions in the original design. As-built drawings shall be submitted before final payment for completed work will be made.

### **470.7 MAINTENANCE OF TRAFFIC SIGNALS AND RELATED ITEMS DURING CONSTRUCTION:**

Unless otherwise specified, the City of Phoenix will operate and maintain the existing traffic signal equipment during construction. Once new traffic signal equipment is in place and accepted, the City of Phoenix will assume operation and maintenance responsibilities.

Unscheduled traffic signal work or maintenance calls performed by the City caused by contractor damage or negligence to an existing signalized intersection will be billed directly to the contractor. For after-hours support, the contractor can contact the City of Phoenix Traffic Signal Shop at (602) 262-6021.



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### SECTION 471 ELECTRICAL UNDERGROUND INSTALLATION

#### **471.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing electrical conduit and pull boxes for traffic signals and intersection lighting including jacking, drilling, excavating, placing, and compacting backfill material in accordance with the locations shown on the approved traffic signal plan.

#### **471.2 MATERIALS:**

**471.2.1 PVC Electrical Conduit:** All conduit and conduit fittings shall be listed by UL and conform to NEC standards. Except as specified below, PVC conduit to be installed underground or in concrete structures shall be rigid polyvinyl chloride (PVC) conforming to the requirements of UL 651 for rigid nonmetallic conduit. PVC conduit and conduit fittings shall be schedule 40, heavy wall, manufactured from high impact material and shall be rated for use at 90° C.

All PVC conduits shall be stored and handled in an approved manner to minimize ultraviolet deterioration due to exposure to sunlight.

**471.2.2 HDPE Electrical Conduit:** All conduit and conduit fittings shall be listed by UL and conform to NEC standards. Except as specified below, HDPE conduit to be installed underground or in concrete structures shall be High Density Polyethylene (HDPE) conforming to the requirements of UL 651A for flexible nonmetallic conduit. HDPE conduit and conduit fittings shall be schedule 40.

All HDPE conduits shall be stored and handled in an approved manner to minimize ultraviolet deterioration due to exposure to sunlight.

**471.2.3 Rigid Metallic Conduit:** All exposed conduit and conduit fittings to be installed above ground shall be rigid metallic type manufactured of galvanized steel conforming to requirements of UL 6 for rigid metallic conduit and to NEC standards.

**471.2.4 Pull Boxes:** Pull boxes and pull box extensions shall be constructed of high-density reinforced concrete. Pull box covers shall be made of lightweight reinforced resin. Pull boxes and covers shall be concrete gray color, rated for and meet AASHTO H-20 specifications. Pull boxes shall be stackable for extra depth. Box sizes shall be acceptable industry standard and use nominal lid sizes of:

- #3.5 Junction box 10" x 15"
- # 5 Junction box 13" x 24"
- #7 Junction box 17" x 30"



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Additionally, boxes shall be a minimum of 12” in depth and have no floors or mouse holes.

All junction boxes shall have an 18” minimum depth sump with a ¾” minimum diameter gravel.

Covers shall be cast to allow securing with two (2) corrosion resistant metallic hex bolts with corrosion resistant metallic washers and nuts. Covers shall also be cast with a non-skid resistant surface and have a nominal thickness of two inches.

The words “TRAFFIC SIGNAL” shall be cast in the pull box covers in 1-inch-high letters. At the request of the Engineer, the contractor shall furnish pull box plans and specifications.

Utility specific pull boxes for service runs and streetlighting shall meet the requirements of the specific utility company for materials used.

Chipped or cracked pull boxes, covers, and extensions will not be accepted.

Metal covers are **NOT** acceptable.

**471.2.5 Detectable Mule Tape:** A detectable mule tape is a flat, woven, polyester tape with an insulated locating conductor. The conductor shall be a metallic 22 gauge insulated wire. The mule tape shall be a minimum 1/4-inch width with a pull strength of 400 pounds.

### **471.3 CONSTRUCTION REQUIREMENTS:**

**471.3.1 General Requirements for Trenching/Boring:** Conduit will be placed in a variety of locations such as under existing pavement or sidewalk, under sod or other pervious surfaces, under new pavement as well as different soil conditions requiring either normal trenching/boring or hard soil such as in rock or caliche. The payment for this section will be divided into multiple categories.

It is the intent of this contract that boring shall be used for conduit runs under existing pavement (street crossings and driveways) or conduit runs greater than 25 feet. The contractor can utilize open trenching when directional boring is not feasible due to utility conflicts or soil conditions, with the approval of the COP Traffic Signal Engineer or designee.

**471.3.2 Conduit Depth Requirements:** Conduits installed in protected areas such as behind curbs, under sidewalks, etc. that are not subject to any vehicular traffic shall be at a minimum depth of 24 inches below final grade. Conduit installed under roadways, driveways, or any open area where there is the possibility of vehicular traffic, shall be installed at a minimum depth of 24 inches below final grade. Unless otherwise stated on the plans, conduit depths shall not exceed 40 inches. When conduit cannot be installed at the minimum depth, it shall be completely encased in 4” of class C concrete in accordance with Section 725. Conduit shall not be installed below 40 inches without approval for the COP Traffic Signal Engineer or designee.





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**471.3.3 Trenching, Backfilling, and Compaction:** Trenches shall not be excavated wider than necessary for the proper placement of conduit and pull boxes. Trenching shall be done in accordance with Section 601. Backfilling, compaction, and bedding of conduit runs shall be in accordance with Section 601.4.9.

Open trench excavation across any existing paved areas, shall have two (2) parallel cuts made at a distance not to exceed 16 inches. All removal and replacement of existing paved areas shall be in accordance with Section 336 and paid for separately.

Open trench excavation across an existing Portland concrete area shall have two (2) parallel cuts made at a distance not to exceed 16 inches. All removal and replacement of existing Portland concrete areas shall be done in accordance with Section 336 and paid for separately.

After each excavation is complete and materials are in place, the contractor shall notify the Engineer for inspection, and under no circumstances shall any underground material or equipment be covered with fill without proper approval.

**471.3.4 General Requirements for Boring:** Conduit will be directional bored under existing pavement or sidewalk surfaces. Depth of conduit is measured from the top of grade to the top of the conduit at a depth not to exceed 40 inches.

Where conduit is to be installed under existing roadway pavement by jacking or drilling methods, the jacking and/or drilling pits shall be kept 2 feet clear of the edge of the pavement.

**471.3.5 General Requirements for Installation of Electrical Conduit:** Conduit shall be furnished and installed at the locations and of the sizes shown on the approved traffic signal plan. Unless changes are necessary to avoid underground obstructions, all underground conduit shall be installed in a straight line from pull box to pull box and/or from foundation to pull box and shall be of one continuous size. Any change in conduit routing must be approved by the Engineer and documented by the contractor on as-built traffic signal plans.

Conduit entering pull boxes shall terminate a minimum of 3" inside the box wall. The conduit shall be between 2" and 4" above the bottom. Conduit entering through the bottom of a pull box shall be located near the sides and ends and extend no more than 4" above the bottom of the pull box including the length of the conduit bell end to leave the major interior portion clear. At all outlets, conduits shall enter from the direction of the run and allow for expansion and contraction.

All conduit shall have a detectable mule tape or a #10 AWG bare copper conductor installed that extends 36 inches beyond each end of the PVC conduit run between pull boxes and foundations.





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The mule tape or bond wire shall be coiled and inserted into the conduit to be easily recovered from either end.

Installation of conduit for underground electrical service shall be in accordance with the COP Traffic Signal Standard Details, as shown on the approved traffic signal plan and in accordance with the requirements of the utility company providing electrical service. Conduit installed in railroad right-of-way shall be installed in accordance with the requirements of the railroad company.

A typical installation will use PVC conduit. HDPE conduit will be used for depths greater than 45 inches or for boring installations greater than 50 feet. The contractor may request a variance with approval from the COP Traffic Signal Engineer or designee.

**471.3.5.1 PVC Conduit Requirements:** The PVC conduit shall be cut square and trimmed to remove all rough edges. PVC conduit connections shall be of the solvent weld type. Purple primer conforming to the requirements of ASTM F 656 shall be applied to the joined surfaces prior to use of cement. The joint cement shall be the gray PVC cement conforming to the requirements of ASTM D 2564. Where a connection is made to rigid metallic conduit, the coupling used shall be a PVC female adapter.

Field PVC conduit bends shall be made without crimping or flattening, using the longest radius practical but not less than specified by the NEC. Collapsed conduit, no matter how small, is not acceptable. The amount of bends between pull boxes or between pull box and foundations shall not contain more than equivalent of two quarter bends (180 degrees, total), including the bends at the pull boxes or foundations, unless authorized by the Engineer.

Conduit entering a pull box or foundation shall be fitted with a factory made 90-degree elbow with a minimum sweep radius per the table below:

<u>Conduit Size</u>	<u>Sweep Radius</u>
2 inches	15 inches
2 ½ inches	18 inches
3 inches	21 inches

Conduit ends shall be capped with conduit end cap fittings after the mule tape is installed. Conduit end cap shall remain in place until wiring is started. When end caps are removed, PVC ends shall be provided with an approved conduit end bell. End bells shall be installed prior to the installation of the conductors.



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Conduit stub-outs under curbs or roadway edges for loop detection lead-in conductors shall conform to the requirements of City of Phoenix Street Transportation Department Traffic Signal Standard Details.

**471.3.5.2 HDPE Conduit Requirements:** HDPE conduit shall be one continuous run without any conduit splices.

All HDPE conduit shall be cut square and trimmed to remove all rough edges at each end. Bending of materials shall be in accordance with the manufacturer's recommended installation procedures and shall be installed without crimping or flattening. Collapsed conduit, no matter how small, is not acceptable.

**471.3.5.2 Rigid Metallic Conduit Requirements:** All rigid metallic conduit shall be installed in accordance with the NEC and the approved traffic signal plans.

**471.3.6 General Requirements for Installation of Pull Boxes:** Pull boxes shall be installed in accordance with the COP Traffic Signal Standard Details for pull boxes. All relocation of pull boxes to avoid driveways and/or other structures shall be approved by the Traffic Signal Engineer or designee and documented by the contractor on the as-built traffic signal plans.

All pull boxes shall be installed fully in the sidewalk or outside of the sidewalk. Pull boxes shall be set and adjusted so that they are flush at curb or sidewalk grade. When no grade is established, pull boxes shall be set as requested by the Traffic Signal Engineer or designee. All pull box covers shall be secured with the required bolts and washers before final acceptance of the project. All pull boxes shall be left in clean condition, free of dirt and debris upon completion of the work.

Utility specific pull boxes for electric service runs or for streetlights shall be installed in accordance with the specific utility drawings and requirements including the grounding system.

**471.3.7 General Requirements for Installation of Detectable Mule Tape or #10 AWG Bare Copper Conductor:** Conduit for future use shall have a detectable mule tape or #10 AWG bare copper conductor installed that extends 36 inches beyond each end of the conduit run between pull boxes and foundations. The mule tape or conductor shall be coiled and inserted into the conduit to be easily recovered from either end. Conduit ends shall be capped with conduit end cap fittings after the detectable mule tape or #10 AWG bare copper conductor is installed. Conduit end cap shall remain in place until wiring is started.

### **471.4 MEASUREMENT:**

Conduit will be measured by linear foot by type of conduit (PVC, HDPE, or rigid metallic) and by diameter size. Measurements shall be taken between edges of junction box or foundation to the other end of the conduit run or length of conduit attached to a structure or pole.



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Pull boxes will be measured as a unit price for each, by pull box size. Pull boxes at the utility point of feed will be measured at a unit price for each, by the utility company (APS and SRP).

Trenching will be measured by linear foot, depth of trench (less or greater than 45 inches), surface type (under new pavement/landscaping or existing pavement) and by soil type (normal or hard soil). Measurements shall be taken from edge of junction box or foundation to the other end of the trench at a junction box or foundation.

Boring will be measured by linear foot, by soil type. Measurements shall be taken by length bored from beginning to end of bore at full depth. Any remaining distance from end of full depth to termini of bore at a junction box or foundation will be paid for separately.

Rigid Metallic conduit attached to structure shall be measured by linear foot of conduit attached to a structure or pole.

### **471.5 PAYMENT:**

The accepted quantities of conduit, measured as provided above, will be paid for at the contract unit price per linear foot by type of conduit (PVC, HDPE, or Rigid Metallic) and by diameter size, which shall be full compensation for the supply of the item including the detectable mule tape or #10 AWG bare copper conductor required in each conduit. No direct payment will be made for conduit bends at pull boxes, expansion fittings, coupling fittings, metallic accessories (LB, SLB, etc.) and excess detectable mule tape or #10 AWG bare copper conductor required at either end of the conduit run; the costs being considered as incidental to the conduit, junction box, or the foundation wherever the incidental item is contained or used.

The accepted quantities for pull boxes, measured as provided above, will be paid for at the contract unit price, each, which shall be full compensation for the supply and installation of the item, COMPLETE IN PLACE, including any excavating, backfilling, and landscaping necessary to complete the work. Conduit inside the junction box shall be considered incidental to the cost of the junction box. The unit price for utility specific pull boxes shall include the ground rod and conductor either in the pull box or at the location shown on the plans or as directed, COMPLETE IN PLACE.

The accepted quantities for trenching under existing pavement, measured as provided above, will be paid for at the contract unit price, by linear foot, by depth, by soil condition, which shall be full compensation for excavating the trench, installing the conduit(s) and backfilling COMPLETE IN PLACE, including any excavating, backfilling, landscaping and surface restoration (asphalt or concrete) to match original conditions necessary to complete the work. Supply of conduit shall be paid for separately.

The accepted quantities for trenching under new pavement or landscaping, measured as provided above, will be paid for at the contract unit price, by linear foot, by depth, by soil condition,



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which shall be full compensation for excavating the trench, installing the conduit(s) and backfilling COMPLETE IN PLACE, including any excavating, backfilling, landscaping and surface restoration to match original conditions necessary to complete the work. Supply of conduit and installation of new pavement or concrete shall be paid for separately.

The accepted quantities for boring, measured as provided above, will be paid for at the contract unit price, by linear foot, which shall be full compensation for bore pit, drilling the bore, and installing the conduit(s) COMPLETE IN PLACE, including any excavating, backfilling, and landscaping to match original conditions necessary to complete the work. Supply of conduit shall be paid for separately.

The accepted quantities for attaching to structure, measured as provided above, will be paid for at the contract unit price, by linear foot, which shall be full compensation for attaching metallic conduit COMPLETE IN PLACE, including any attachment hardware and metallic accessories (LB, SLB, etc.) necessary to complete the work. Supply of conduit shall be paid for separately.



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### SECTION 472 TRAFFIC SIGNAL FOUNDATIONS

#### **472.1 DESCRIPTION:**

The work under this section shall consist of furnishing all materials and constructing all traffic signal support foundations and other designated pole foundations, as well as cabinet and electrical service pedestal foundations for the traffic signals in accordance with the locations and as shown on the Foundation Sheets of the approved traffic signal plan and details designated on the COP Traffic Signal Standard Details, and ADOT Standards. Foundations shall include all conduits, conduit elbows, anchor bolts, reinforcing steel, grounding electrode, and other embedded appurtenances.

The controller and power service pedestal cabinet foundations shall conform to the requirements of COP Traffic Signal Standard Details.

#### **472.2 MATERIALS:**

**472.2.1 General:** Certificates of Analysis including description of material supplied, quantity represented by the certificate, means of material identification (such as label, lot or marking), statement the material complies with the requirements of the cited specification, name, title and signature of person having authority to bind the manufacturer or supplier of the material, and results of tests required by the specification shall be submitted for all structural steel and high-strength bolts.

**472.2.2 Excavation and Backfill:** Trenches shall not be excavated wider than necessary for the proper placement of conduit and pull boxes. Trenching, backfilling, and compaction shall be done in accordance with Section 601 of the MAG Specifications.

All excavations within the roadway shall be backfilled and compacted in accordance with Section 206 of the MAG Specifications.

**472.2.3 Concrete:** Concrete used for all foundations shall be MAG class 'A', 3000psi, 4000psi or 5000psi concrete with a 4"-6" slump and shall be in accordance with the requirements of MAG Section 725, except as noted herein. All concrete shall have a maximum water/cement ratio of 0.45. Maximum aggregate size to be 1 ½".

**472.2.4 Anchor Bolts:** Anchor bolts, nuts and washers shall conform to the requirements shown on Traffic Signal Details.

**472.2.5 Reinforcing Steel:** Steel bars used as reinforcement in concrete shall be deformed and conform to the requirements of ASTM A615, Grade 60.



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**472.2.6 Rebar Cage:** The Rebar Cage is the assembly of the reinforcing steel and the Anchor Bolts as shown in the City of Phoenix COP Traffic Signal Standard Details.

**472.2.7 Electrical Conduit:** All electrical conduit and conduit fittings shall be sized as shown on the Foundation Sheets of the approved traffic signal plan and in accordance with these specifications. All foundation conduits shall be grey Schedule 40 PVC.

**472.2.8 Grounding Electrode:** The grounding electrode shall be in accordance with these specifications and COP Traffic Signal Standard Details.

A 25-foot coil of #4 AWG stranded bare copper grounding electrode shall be installed at the base of the pole foundations and extend centered, two feet above the top of the foundation.

Service pedestal foundations shall have 1-inch PVC ground rod sleeve, 1-inch PVC stub-out for additional grounding if needed, and a 5/8-inch x 10-foot bonded copper grounding rod driven into the ground prior to the power pedestal foundation being poured. The ground rod shall protrude 6 inches above finished grade of the power service foundation.

### **472.3 CONSTRUCTION REQUIREMENTS:**

**472.3.1 Utility Potholing:** When underground utility conflicts are revealed by blue stake or shown on the plans, the contractor may be required to conduct Utility Potholing for Conduit runs or Foundations as directed by the COP Traffic Signal Engineer or designee.

**472.3.2 Excavation and Backfill:** Foundations will be placed in different soil conditions requiring drilling in normal soil conditions or hard soil such as in rock or caliche; or soft digging to identify and avoid utility conflicts.

The excavations required for the installation of foundations and other items shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping and other improvements. Any damage caused by the contractor's operation shall be replaced or reconstructed where determined by the COP Traffic Signal Engineer or designee at the expense of the contractor. The foundations shall not be excavated wider than necessary for the proper construction of the foundations and other equipment. Excavation shall not be performed until immediately before the construction of foundations. The material from the excavation shall be placed in a position that will minimize obstructions to traffic and interference with surface drainage.

All surplus excavated materials shall be removed and properly disposed of within 48 hours by the contractor, as directed by the COP Traffic Signal Engineer or designee. After each excavation is completed, the contractor shall notify the Signal Shop designee for inspection. Under no



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circumstances shall any underground materials or equipment be covered with fill without the approval of the COP Traffic Signal Engineer or designee.

At the end of each working period, all excavations shall be barricaded or covered, or both, to provide safe passage for pedestrian and vehicular traffic.

Excavations in the street or highway shall be conducted in such a manner that not more than one traffic lane is restricted at any time, unless otherwise provided in the Special Provisions.

sidewalk and pavement excavations shall be kept well covered and protected to provide safe passage for pedestrian and vehicular traffic until permanent repairs are made.

**472.3.3 Installation:** The elevation of signal pole foundations shall be set as follows unless otherwise noted within the construction plans or special provisions. Signal pole foundations shall be set flush ( $\pm 1/4"$ ) with the existing or new sidewalk when sidewalk is present. Where curb exists without sidewalk, the foundations shall be set flush with a surface defined by a 1.5% upward slope from the top of curb ( $\pm 1/2"$ ). Where there are no curb or sidewalk pole foundations shall be as shown on the project plans. The dimensions and locations of foundations shall be as specified on the project plans; however, the COP Traffic Signal Engineer or designee may direct that changes be made in locations due to obstructions or other existing conditions. Any change in locations shall be documented by the contractor on as-built traffic signal plans. The contractor shall verify top of foundation elevations with the COP Traffic Signal Engineer or designee prior to foundation construction.

Anchor bolts shall be oriented such that the bolt pattern sides are both parallel and perpendicular to the roadway centerlines unless otherwise specified on the approved traffic signal plan. Anchor bolts, conduit, and rebar cage shall be centered within the foundation, set at the specified height and plumb within  $\pm 1/2$  degree. During placement of concrete, anchor bolts shall be securely held in proper alignment, position, and height with a suitable template.

A 25-foot coil of No. 4 AWG bare copper conductor shall be installed 4" below the foundation and covered with 4" of fill material such that no part of the coils will be in contact with the concrete foundation. An extension of the No. 4 AWG bare copper wire shall extend into the pole.

Installation of anchor bolts shall ensure that when assembled, all joint surfaces including those adjacent to the washers, shall be free of scale, except tight mill scale, and free of foreign material or debris. If bolt pretension or installation torque requirements are not specified in plans, anchor bolts are permitted to be installed to only the snug-tight condition. The snug-tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the connected plies into firm contact.

After excavations are completed and anchor bolts, reinforcing, ground wire, and conduit installed, the contractor shall notify the Signal Shop designee for inspection. Under no circumstances shall





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concrete be placed without approval of the COP Traffic Signal Engineer or designee. A Signal Shop designee shall be on-site when concrete is poured.

**472.3.4 Construction:** Concrete shall be placed in holes which have been augured against undisturbed earth. If the material at the bottom of the hole is not firm and stable, it shall be compacted or treated as directed by the COP Traffic Signal Engineer or designee. The walls and the bottoms of the holes shall be thoroughly moistened prior to placing concrete.

If the soil is not stable, a deeper foundation than specified may be required or forms shall be used as determined by the COP Traffic Signal Engineer or designee. The forms shall be of the proper size and dimensions and shall be rigid and securely braced.

Foundation forming material shall extend no more than 20 inches below the foundation final grade and shall be removed after placement and curing of concrete.

The concrete pour shall be continuous and consolidated by means of vibrators to within at least 10" of the finished grade. All exposed surfaces of the foundation shall receive a broom finish that is smooth, level, and free of form marks. Type 'A', 'AP', and 'BP' pole foundations, cabinet foundation, and service pedestal foundation shall set for a minimum of five (5) days prior to installation of poles and/or cabinets. All other pole foundations shall set for ten (10) days or until concrete cylinder breaks reach a minimum of 3000psi prior to installation of poles. Either at the request of the City or the contractor, higher strength concrete can be used to accelerate the installation of Traffic Signal poles with the approval of the COP Traffic Signal Engineer or designee. If used, concrete cylinder breaks must reach a minimum of 3000psi prior to installation of poles. If requested by the City, the contractor will be compensated for the additional cost of the higher strength concrete based on the volume of concrete used for the foundation.

**472.3.5 Foundation Grounding Testing:** A ground resistance test shall be performed for each installed ground rod prior to final connection of the utility service. Pole foundation coil grounds shall be tested as determined by the Engineer or designee in the field.

The ground resistance shall be measured with a three terminal, fall of potential, direct reading, battery powered earth tester with a 0.50-to-500-ohm scale or digital read-out. The 25-ohm reading shall be approximately at mid-scale.

The test shall be performed according to the manufacturer's instructions and OSHA requirements. Two auxiliary copper clad ground rods shall be driven into the ground a minimum of 3 feet. The lateral spacing for each test rod shall be given in writing on the test report form and the spacing shall be approved by the Engineer or designee.

All tests shall be performed in the presence of the Engineer or designee and the test results shall be written down, dated, and given to the Engineer or designee for approval.





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Each ground rod or foundation ground shall be isolated with the bond wires disconnected when the test is being performed. The resistance to ground shall be 25 ohms or less. If it is not, additional ground rods shall be installed as required at least 15 feet from the original ground and shall be bonded to it. The test shall then be repeated for multiple grounds as necessary to achieve proper grounding below 25 ohms. As many additional ground rods shall be installed as is necessary to achieve proper grounding of 25 ohms or less.

The test shall be performed when the soil is dry. The contractor shall not add any chemical or salt solutions to any portion of the grounding system. All grounding rods and foundation grounds to be tested shall be installed a minimum of ten days prior to testing unless otherwise determined by the Engineer or designee in the field.

### **472.4 MEASUREMENT:**

Utility Potholing shall be measured by each by whether the pothole is in the roadway or not in the roadway.

Foundations for traffic signal poles and cabinets will be measured as a unit for each type of foundation constructed by soil or avoiding utility conditions.

If used, higher strength concrete will be measured by cubic yard of concrete used in the foundation.

### **472.5 PAYMENT:**

The accepted quantities of utility potholing (In Roadway or Not In Roadway), measured as provided above, will be paid for at the contract unit price. Payment shall be full compensation for the work, COMPLETE IN PLACE, including excavations, concrete, backfill, pothole surface material, and any incidentals necessary to complete the work.

The accepted quantities of foundations for traffic signal poles and cabinets measured as provided above, will be paid for at the contract unit price by type of foundation and soil condition. Payment shall be full compensation for the work, COMPLETE IN PLACE, including excavations, concrete, backfill, conduit within foundation, grounding system, grounding system testing, and incidentals necessary to complete the work. If requested by the City and authorized by the COP Traffic Signal Engineer or designee, the accepted quantities for higher strength concrete (4000psi or 5000psi) as measured above, will be paid for at the contract unit price in addition to the unit price for the foundation.



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### SECTION 473 DETECTORS

#### **473.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing vehicular and pedestrian detectors at the locations and sizes shown on the approved traffic signal plan and in accordance with the requirements of these specifications and the COP Traffic Signal Standard Details. Homerun shielded loop detector cable shall be installed and paid for under electrical conductors.

#### **473.2 MATERIALS:**

**473.2.1 Loop Detector Sensor Wire:** Loop detector sensors shall be of the size and type specified on the traffic signal plan and shall conform to the requirements of COP Traffic Signal Standard Details. Roadway loop detector sensor wire shall conform to IMSA specification 51-5 with orange jacket and installed in accordance with the requirements of these specifications and COP Traffic Signal Standard Details.

**473.2.2 Cold Applied Emulsion Sealant:** The loop sealant shall be a single component asphaltic emulsion sealant designed to fill and seal inductive loop saw cuts. Loop sealant shall be “Tri-American TA-500” or approved equal.

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TEST PARAMETER	LIMITS	TEST METHOD
Residue by evaporation, weight percent	70 min	ASTM D 2939
Ash content, weight percent	50 min	ASTM D 2939
Firm set time, hours	4 max	ASTM D 2939
Brookfield viscosity, Poise RVT Spindle #3, 10 RPM at $75 \pm 2$ ° F	50 to 125 °F	
Tensile strength, psi	20 min	ASTM D 2523
Elongation, %	2.0 min	ASTM D 2523
Flexibility	No full depth cracks	ASTM D 2939 SEE NOTE BELOW
Resistance to water	No blistering, re-emulsification or loss of adhesion	ASTM D 2939, Alternative B



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**NOTE:** Flexibility: Except air-dry specimens to constant weight at  $75^{\circ} \pm 5^{\circ}$  F and  $50^{\circ} \pm 10^{\circ}$  F relative humidity. Condition the mandrel and specimens for 2 hours at  $75^{\circ} \pm 2^{\circ}$  F before test.

**473.2.3 Pedestrian Detectors General Requirements:** The standard required pedestrian detector shall be the Accessible Pedestrian Signal Detector as described below unless the plans specify a pedestrian push button. All pedestrian detectors shall be in accordance with the Americans with Disabilities Act Accessibility Guidelines (latest revision). Pedestrian detectors shall be installed as per COP Traffic Signal Standard Details.

**473.2.3.1 Pedestrian Push Buttons:** Standard pedestrian push buttons (bullnose) shall meet the following specifications:

1. Body and cover shall be cast aluminum using four (4) brass or stainless-steel Phillips head screws, #8 x 32 x 1", for securing the cover to the body.
2. Body and cover must have an industry standard bolt pattern and design to allow for retrofit of existing units in the field.
3. Body shall be without a sign mount and approximately three (3) inches in diameter.
4. Operation button shall be stainless steel two (2) inches in diameter, (large ADA), with tamper-proof vandal resistant housing.
5. Operating switch shall be mechanical (no exceptions).
6. The switch shall be the phenolic-enclosed SPST-type with momentary contacts.
7. The switch shall operate in the normal open position.
8. The switch shall have screw-type terminals and shall have a rated life of not less than one million operations.
9. The contacts shall be rated at 15 amps and 125 volts AC.
10. Cover and body will be painted black. Powder coated will be accepted.
11. The body of each pedestrian push button assembly shall have a 1/2" to 3/4" hole located in the center of the base assembly. There shall also be two (2) 5/16" holes in the base assembly 1" above and 1" below the center point in the back of the housing.
12. Each base assembly shall have a curved back or be supplied with a "U" channel mounting bracket to facilitate the mounting of the assembly on round pole surfaces.
13. The mounting bracket shall be 2 1/2" long and 1 1/8" wide with 3/8" flanges on each side. Each mounting bracket shall have a 7/8" hole in the center of the bracket and 5/16" holes located 1" above and 1" below the center of the 7/8" hole.

**473.2.3.2 Accessible Pedestrian Signal Push Buttons (APS):** APS push buttons shall meet the following specifications:

**A. General:**

1. Conform to applicable sections of the current MUTCD Part 4: Chapter 4K, Pedestrian Control Features as specified herein.
2. All features are fully operational when the traffic signal is in stop-and-go mode.



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3. All features are non-operational when the traffic signal is in flash mode.
4. Interchangeable with a non-accessible type of pedestrian pushbutton with no modifications to the Controller Assembly (CA) or Controller Unit.
5. Audible transducer is integral with the APS&D housing, adjacent to the pushbutton.

### B. Electrical:

1. Metallic components either grounded or insulated to preclude an electrical hazard to pedestrians under all weather conditions.
2. All features powered by the 110VAC Walk signal and the 110VAC Don't Walk signal so that additional conductors from the CA are not needed.

### C Audible Pushbutton Locator

1. Frequency: repeating tone at one (1) cycle per second
2. Tone duration:  $\leq 0.15$  seconds
3. Volume:
  - a. Minimum setting of zero
  - b. Manually adjustable initial setting
  - c. Automatically adjusted after initial setting. Volume increased in response to a temporary increase in ambient noise and subsequently decreased with a decrease in ambient noise.
  - d. Maximum volume: 100 dBA which is the approximate sound pressure of a gasoline powered lawn mower nearby.
  - e. Automatic volume adjustment independent of other APS&Ds at the intersection.
  - f. May be disabled without affecting operation of audible pedestrian signal.
4. Silent only during walk intervals. Active all other times.

### D. Vibratory Tactile Arrow Pushbutton

1. Pushbutton contained in a circular assembly which fits inside the housing and is attached to the housing with 4 screws.
2. ADA compliant: Size:  $\geq 2.0''$  (50) diameter, Actuation force:  $\leq 5$  ft-lb (22.2 N)
3. Shape: Circular, raised slightly above housing so that it may be actuated with the back of a hand
4. Tamper-proof, vandal-proof, weatherproof, freeze-proof, impact-resistant design and construction.
5. Actuation method: Piezo technology. Mechanical not allowed.
6. Operation: Vibrates only when walk signal is displayed. Inactive all other times
7. Tactile Arrow:
  - a. Attached to surface of the button assembly by a tamperproof method that allows direction of arrow to be field adjusted left or right to be parallel to the corresponding crosswalk.
  - b. Raised slightly above surface of pushbutton, minimum 0.125'' (0.3).
  - c. Size: Length  $\geq 1.5''$  (38), Height  $\geq 1.0''$  (25)
  - d. Color: Sharp contrast to background color of pushbutton and housing

### E. Audible Walk Interval

1. Operation independent of other APS&Ds at intersection.
2. Active only during the walk interval (when the walk signal is displayed).
3. Volume:
  - a. Minimum setting of zero
  - b. Manually adjustable initial setting



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- c. Automatically adjusted after initial setting. Volume increased in response to a temporary increase in ambient noise and subsequently decreased with a decrease in ambient noise.
  - d. Automatic volume adjustment independent of other APS&Ds at the intersection.
  - e. Maximum volume: 100 dBA which is the approximate sound pressure of a gasoline powered lawn mower nearby.
  - 4. Duration:
    - a. Default method: Automatically set by the duration of the visual walk signal display.
    - b. When selected: Manually set when rest-in-walk is used for a concurrent pedestrian movement.
  - 5. Audible sounds that mimic any bird call are not allowed.
- F. Type A, Percussive Tone:
- 1. Repeating tone at eight (8) to ten (10) ticks per second.
  - 2. Tone frequency: Multiple frequencies with a dominant component at 880 Hz which creates a “tick - tick - tick...” sound.
- G. Pushbutton Housing/Sign Frame/Sign
- 1. One piece die cast aluminum meeting requirements of ASTM B85.
  - 2. Sign frame designed to accept 9" x 12" (230 x 300) four-hole advisory sign.
  - 3. Flat back to facilitate surface mount.
  - 4. Available brackets to either pedestal top-mount or pole side-mount on pole diameter range of 3½" (89) to 15" (380).
  - 5. Available brackets to allow mounting two (2) APS&Ds to the same 3½" (89) pole, facing  $\geq 60$  degrees apart, at the same height.
  - 5. Wire entrance through the rear.
  - 6. Stainless steel mounting hardware.
  - 7. Color: Dark Green, Federal No 14056, Federal standard No. 595
    - a. Finish: Housing/Frame and all mounting brackets either:
    - b. Painted with 3 coats of infrared oven-baked paint before assembly.
    - c. Primer: Baked iron oxide which meets or exceeds FS TT-P-636.
    - d. Second coat: Exterior-baking enamel, light gray, which meets or exceeds FS TT-E-527.
    - e. Third coat: Exterior-baking enamel, which meets or exceeds FS TT-E-489.
    - f. Electrostatic powder coated after chemically cleaned.
  - 8. Sign: MUTCD R10-3e

**473.2.4 Non-Intrusive Detection System:** Each intersection shall be equipped with a “non-intrusive” detection system installed in accordance with the manufacturer’s installation instructions and requirements of these specifications. “Non-intrusive” is defined as having no devices embedded in the roadway surface or subsurface. These include video, radar, and thermal imaging detection systems.

- A. As a minimum, a single detector shall be capable of capturing vehicles and bicycles in each lane up to four vehicle lanes and one bicycle lane per approach at the stop bar.
- B. Provide lane-by-lane vehicular detection zone(s) to extend a minimum of 100 feet from the stop bar.
- C. An optional feature would be to distinguish bicycles from vehicles at the stop bar.



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- D. When specified, provide advanced vehicular detection at a maximum distance of 400 feet from the stop bar.
- E. The detection system shall be capable of emulating the current third car detection system used by Phoenix in signalized left turn lanes. This requires independent multiple detection zones within a single lane.
- F. If detection processor cards are used, no more than four (4) detection processor cards shall be required for a standard 4-legged intersection.
- G. No more than 4 detector slots shall be used for a standard 4-legged intersection.
- H. Detection cards where used shall be compatible with NEMA TS/2 Cabinets, Econolite Cobalt Classic, and Cobalt ATC controllers.
- I. The manufacturer shall provide a conversion kit for use in a TS/1 cabinet.
- J. Detection equipment and power supplies shall be rated to operate properly at a minimum between -34°C and +74°C, (-30°F and +165°F). Power requirements shall be compatible within a TS/1 and TS/2 cabinet.
- K. Camera detection systems shall have the ability to transmit MPEG4, MJPEG or H.264 video compression over TCP/IP network. The TMC client software shall have the ability to configure detection zones within the selected camera view and have the ability to upload/download the current configuration to the camera detector processor.
- L. Camera detection shall have the ability to detect and ignore vehicle shadows traversing the detection zones.
- M. Image detection systems shall have the ability to stream images from all cameras at the intersection simultaneously without adverse effects to the detection or the image stream.
- N. The detection system shall be capable of providing vehicle turning movement counts and speeds through its software.

### *Network Communication Requirements*

- O. The detection equipment shall be compatible with standard TCP/IP Ethernet communication protocols and have the ability to be configured remotely from the Traffic Management Center (TMC). It shall be compatible with Tropos Communications routers and be able to transmit data through a Tropos Mesh network, fiber communications network and P2P wireless radios.
- P. The detection processor(s) shall have an Ethernet RJ45 interface and have the ability to be configured locally and remotely via web interface or client software. Client software shall be compatible with Win7 to the current Windows operating systems and Firefox, Internet Explorer and Chrome latest version browsers.
- Q. The detection processor shall be capable of remote access for all of the detectors attached to that processor at the same time.



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- R. Detection systems shall have the ability to transmit broadband communication over TCP/IP network.
- S. The TMC client software shall have the ability to configure detection zones within the selected detector view and have the ability to upload /download the current configuration to the detector processor.
- T. The manufacturer shall have the capability to remotely record detection operation (images and detection zones) through the RJ45 connection.
- U. The manufacturer shall have the capability to save configurations by time- of-day.
- V. Client software and detection firmware updates shall be provided and have the ability to be upgraded by the City of Phoenix signal technician staff at no cost to the City.
- W. Non-intrusive Detection equipment shall be an Econolite Camera Detection System, FLIR Thermal Imaging Camera System, Wavetronix, NoTraffic, Currex, or Iteris that meets the above requirements; or approved equal.

### **473.3 CONSTRUCTION REQUIREMENTS:**

**473.3.1 Vehicular/Bike Loop Detector Sensors:** Vehicular loop detector sensors of the size and type specified on the approved traffic signal plan shall be installed in accordance with the locations shown on the approved traffic signal plan and the requirements of these specifications. Any change in loop detector sensor location or deviation in loop detector sensor installation not in accordance with these specifications must be approved by the Engineer or designee and documented by the contractor on as-built signal plans. The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise.

#### **473.3.1.1 Loop Detector Sensor Conductor Installation:**

1. Loop placement will be as shown on the plans. The contractor will mark loops in the field and the locations approved in writing by the COP before work on the loop may begin.
2. Slots and cores are to be saw cut and drilled into the final asphalt/concrete base course lift as shown in the COP Traffic Signal Standard Details.
3. To ensure that all saw cuts are true and straight a loop sensor layout shall first be made on the pavement surface.
4. Slots are to be ½" (one-half inch) wide and of sufficient depth to allow 2" (two inches) of sealant coverage.
5. Drill cores, located in corners and ends of center cuts, are to be 2 ½" (two and one-half inches) in diameter and 2 ½" (two and one-half inches) deep.
6. The sawed slot shall extend to the curbside PVC conduit for each loop sensor.





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7. Separate lead-in sawed slots extending from the loop to the stub-out conduit shall be cut for each loop sensor.
8. Slots are to be blown out and dried before installation of wires.
9. Loop conductors are to be installed ONLY in the presence of the COP Traffic Signal Engineer or designee.
10. Loop detector conductors will not be spliced.
11. Each loop is to be wound in the direction and number of turns indicated on the COP Traffic Signal Standard Details.
12. Loop lead-ins from the loop to the junction box are to be wound at three turns per foot. Twisted pairs will be taped full length from the exit of the sawed loop slot in the roadway to the connection with the shielded loop detector cable in the junction box.
13. The beginning conductor will be banded in the junction with the symbol “S”, and the loop identified by a number of taped rings as shown on the Plans.
14. Each loop will be provided with a minimum of 6’ (six feet) of slack in the twisted pair of conductors at the junction box when measured from the top of the junction box.
15. Loops are to be sealed only after completion of successful testing.
16. Testing may be conducted ONLY in the presence of the COP Traffic Signal Engineer or designee. Tests are to include the following:
  - a) Meggar Test – A 600-volt meggar test will show not less than 10 (ten) megohms resistance to ground.
  - b) Continuity – Loop circuit resistance is not to exceed 2 (two) ohms.
17. Successful completion of tests will be documented in writing by the COP Traffic Engineer or designee.
18. After completion of successful testing, the loops are to be sealed.
19. Sealant is to be poured into the slots and drill cores and struck flush with the roadway surface. Excess sealant will be removed from the surface of the roadway.
20. The conduit entrance to the roadway will be sealed in accordance with the COP Traffic Signal Standard Details.
21. All loop installations shall have a 1-year warranty from the final acceptance date.

**473.3.1.2 Sawcut Sealant:** The loop sensor conductors shall be permanently anchored in the sawed slot using the cold applied single component emulsion sealant as specified.





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The sealant shall surround the loop sensor conductors and fill the sawed slot to within 1/8 inch of the pavement surface. Surplus sealant shall be removed from the road surface without the use of solvents. Traffic lane closure shall remain in place until the sealant is set up; contractor shall clean up sealant tracking problems at no additional cost to the City.

The emulsion sealant shall be thoroughly mixed according to the manufacturer's recommendations. The emulsion sealant may be poured directly from container or any other suitable applicator, applied into saw cuts.

**473.3.1.4 Loop Detector Sensor Connection:** Each pair of loop sensor conductors entering the curbside pull box shall be identified as to which loop it represents (i.e. inside lane, outside lane, through lane, or left turn lane) as per COP Traffic Signal Standard Details. Each conductor pair shall also be marked to signify its winding direction, "S" for start and "F" for finish.

Up to three loop detector sensors can be connected to one homerun shielded loop detector cable per curbside pull box at a corner of an intersection. Shielded loop detector cable shall run continuously and unspliced from curbside pull box to the controller cabinet. The loop sensor conductors shall be spliced to the homerun shielded loop detector cables in the adjacent curbside pull box with each loop having its own soldered splice to an individual pair in the shielded loop detector cable. The splice shall be protected with heat shrink tubing. Homerun Shielded Loop Detector Cable is paid for under a separate item.

**473.3.2 Pedestrian Push Button (Bullnose):** Drill appropriate size hole for wire entrance and tap screws as provided by manufacturer's installation instructions at the appropriate height. Mount push buttons to the pole using the hardware as specified by the manufacturer.

Pedestrian push buttons will be wired from the terminal block in the push button to the point of connection in the hand hole at the base of the traffic signal pole plus an additional 16 inches beyond the hand hole with continuous lengths of single conductor wire of the appropriate color. Pedestrian push button wires will not be taped together except at the hand hole in the pole base as shown on the Plans and through drilled pole wire entrance as described herein.

**473.3.3 APS Push Button:** Drill appropriate size hole for wire entrance and tap screws as provided by manufacturer's installation instructions at the appropriate height. Mount APS push buttons to the pole using the hardware as specified by the manufacturer. Install APS controller unit in the appropriate pedestrian signal head.

APS Pedestrian push buttons will be wired from the terminal block in the push button to the point of connection in the hand hole at the base of the traffic signal pole plus an additional 16 inches beyond the hand hole with continuous lengths of single conductor wire of the appropriate color. Pedestrian push button wires will not be taped together except at the hand hole in the pole base as shown on the Plans and through drilled pole wire entrance as described herein. APS push buttons



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have a four-conductor cable that is to be installed in the pole to connect with the APS controller. Unit. If the cable provided is of insufficient length, splice a four-conductor cable with the same color conductors as recommended by the manufacturer to complete the circuit.

**473.3.4 Non-Intrusive Detection System:** Mount the detector to the pole or mast arm using the hardware and installation instructions as specified by the manufacturer. Provide and run the manufacturer's specified wire from the non-intrusive detector from the mount through the mast arm or pole at the point of attachment down the pole, through the conduit and junction boxes to the signal control cabinet. Install the Non-Intrusive detection processor in the signal control cabinet, connect lead-ins from detector. A Traffic Signal Inspector must be present when working on or in traffic signal equipment including poles, mast arms, cabinets, conduits, and junction boxes. Work within the cabinet will require coordination with the Traffic Signal Shop and at least 48-hour notice to have a technician open the cabinet and be present while the cabinet is open. Call can be made to City of Phoenix Traffic Signal Supervisor (602) 708-9896 to make arrangements for both the inspector and technician.

The traffic signal technician will install the processor within the cabinet. The contractor shall make the termination of the field wires to the detection processor. The traffic signal technician will make any additional connections needed in the cabinet between the detection processor and any existing equipment within the cabinet required by the manufacturer.

### **473.4 MEASUREMENT:**

Vehicular/Bike Loop Detector Sensors will be measured as a unit for each size of loop furnished and installed. Pedestrian Push Buttons and APS Push Buttons will be measured as a unit for each type of push button furnished and installed. Non-Intrusive Detection Systems will be measured by intersection (by number of legs instrumented) as a unit furnished and installed.

### **473.5 PAYMENT:**

The accepted quantities of Vehicular/Bike Loop Detector Sensors measured as provided above will be paid for at the contract unit price. Payment for Vehicular/Bike Loop Detector Sensors shall be full compensation for the work, including all saw cuts, loop detector sensor wire, sealant, testing, splicing, and any incidentals for complete installations of detectors COMPLETE IN PLACE.

The accepted quantities of Push Buttons by type measured as provided above will be paid for at the contract unit price. Payment for Push Buttons by type shall be full compensation for the work, including drilling pole, mounting hardware, wiring within the pole, and any incidentals for complete installations of detectors COMPLETE IN PLACE.

The accepted quantities of Non-Intrusive Detection Systems measured as provided above will be paid for at the contract unit price. Payment for Non-Intrusive Detection Systems shall be full



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compensation for the work, providing detectors and detection processors including mounting the detectors, mounting hardware, drilling pole or mast-arm, wiring within the pole, wiring between the pole and signal control cabinet, connectors between the detection processor and existing equipment in the cabinet, and any incidentals for complete installations of detectors COMPLETE IN PLACE.



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### **SECTION 474** **Emergency Vehicle Preemption System**

#### **474.1 DESCRIPTION:**

This specification defines the performance standards and construction criteria for a **TOMAR** optical emergency vehicle preemption detection system. The system shall reliably detect authorized emergency vehicles using optical signals and initiate priority control sequences at traffic intersections.

#### **474.2 DETECTOR UNIT REQUIREMENTS:**

1. 4090-22-ST-IC-W: (2-head, 2-Direction, 2-Channel, 2-LED, w/Integrated Confirmation)
2. 4090-1-ST-IC-W: (1-head, 1-Direction, 1-Channel, 1-LED, w/Integrated Confirmation)
  - a. Senses the optical pulses emitted by properly equipped emergency & transit vehicles.
  - b. Sensor technology for sunlight rejection unmatched by any other system
  - c. Field of View: Conical field of view of 13° (horizontal), centered on the detector's axis.
  - d. Detection Range: Minimum line-of-sight range of 2,500 feet.
  - e. Operating Temperature: -40°C to +75°C.
  - f. Enclosure: UV-stabilized polyamide housing; weather-resistant; electronics fully encapsulated.
  - g. Mounting Interface: ¾" female NPT hub suitable for mast arm or span wire installations.
  - h. Moisture Management: Enclosure shall provide venting or weep hole to release condensation without compromising ingress protection.

#### **474.3 ELECTRICAL REQUIREMENTS:**

- a. Input Voltage: 12–30 VDC.
- b. Current Draw: Maximum of 15 mA.
- c. Cable Type: TOMAR model M913 preemption detector cable. Shielded 4-conductor cable, minimum 20 AWG, with length capacity up to 600 feet between detector and processor.

#### **474.4 OPTICAL SIGNAL PROCESSOR UNIT REQUIREMENTS:**

1. Optical Signal Processor – 4140V2-4
  - a. Integrated Confirmation Technology-closed loop visual feedback.
  - b. Four Channel optically isolated output channels for placing NEM standard signal level calls on traffic controller preempt inputs.



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- c. Typical Signal acquisition time shall be approximately 2.5 seconds
- d. 2500 feet maximum adjustable down to 200 feet in 255 steps for each signal band and approach.
- e. Shall be capable of powering and operating up to four TOMAR 4000 series integrated confirmation enable detectors

### **474.5 ELECTRICAL REQUIREMENTS:**

- a. 120 VAC / 60HZ
- b. -40 to +75 degrees C
- c. Input power shall be MOV protected from AC transients.
- d. Detector inputs shall be Transient Voltage Suppression (TVS) protected from electrical transient.
- e. .5-amp fuse shall be included in the input power connection to protect from electrical transient.

### **474.6 FIELD AND CABINET INSTALLATION SPECIFICATION:**

#### **474.6.1 DESCRIPTION:**

This specification covers the field installation requirements for an optical emergency vehicle preemption system at signalized intersections. The system shall enable authorized emergency vehicles to trigger signal preemption for safe and expedited passage.

#### **474.6.2 MATERIALS:**

- a. Detector Unit: Detector with mounting hardware
- b. TOMAR model M913 preemption detector cable.
- c. Mounting Hardware: Adjustable tilt/swivel bracket compatible with mast arm or span wire

#### **474.6.3 INSTALLATION REQUIREMENTS:**

##### **Detector Placement:**

- a. Mount detector on mast arm at a height of 14 – 18 feet above roadway
- b. Align detector to face approaching emergency vehicle path with 13° (horizontal) conical field of view
- c. Ensure unobstructed line-of-sight for minimum 2,500 feet.
- d. Confirm detector is not exposed to direct sunlight glare
- e. Avoid mounting near signal heads or signage



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### **Electrical Connections:**

- a. Route **TOMAR** model M913 detector cable through conduit to the traffic signal cabinet using continuous, un-spliced runs to maintain signal integrity.
- b. Verify polarity and grounding to ensure compliance with NEMA and NEC standards.
- c. Terminate wiring at designated input board in cabinet and detector:
- d. Follow TOMAR manufacturer's pinout and shielding specifications for detector wiring and cabinet integration. Terminate detector inputs to the designate input rack per NEMA TS2 or TS1 cabinet configurations. Coordinate with the City of Phoenix to confirm correct detector input assignment and directional mapping for each approach.

### **474.6.4 ENVIRONMENTAL PROTECTION REQUIREMENTS:**

- a. Verify detector and cabinet enclosure integrity, including door seals and latch tension
- b. Confirm proper weep hole orientation to prevent internal moisture accumulation
- c. Seal all conduit entries with approved weatherproof fittings per NEC and NEMA standards
- d. Ensure all cable glands meet IP-rated ingress protection requirements
- e. Inspect for corrosion-resistant hardware and proper drainage clearance around mounting points

### **474.6.5 TESTING REQUIREMENTS:**

- a. Conduct functional test using authorized emitter-handheld or vehicle equipment
- b. Verify detection range meets a minimum 2,500 feet line-of-sight specification
- c. Confirm activation of confirmation indicator lights during detection event
- d. Validate correct signal preemption response per traffic controller programming
- e. Document all test results in standardized format and submit to agency for final acceptance

### **474.6.6 DOCUMENTATION WARRANTY:**

- a. Provide installation checklist, wiring diagrams, and aiming instructions
- b. Submit as-built drawings showing detector orientation and cable routing
- c. Warranty: Minimum 10 years of detector unit and mount hardware.



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### SECTION 475 TRAFFIC SIGNAL POLES AND ACCESSORIES

#### **475.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing traffic signal poles, mast arms, extensions, risers, luminaire mast arms and dampers when required in accordance with the equipment sheet of the approved traffic signal plans, the COP Traffic Signal Standard Details.

#### **475.2 GENERAL STANDARD:**

Types of poles to be furnished are as follows:

- |              |                |                 |
|--------------|----------------|-----------------|
| 1. Type 'A'  | 7. Type 'LM'   | 13. Type 'DP45' |
| 2. Type 'AP' | 8. Type 'LP'   | 14. Type 'P70'  |
| 3. Type 'PB' | 9. Type 'SM'   | 15. Type 'DP70' |
| 4. Type 'BP' | 10. Type 'SR'  |                 |
| 5. Type 'G'  | 11. Type 'SQ'  |                 |
| 6. Type 'GP' | 12. Type 'P45' |                 |

**475.2.1 Certificates of Analysis:** The Certificates of Analysis including description of material supplied, quantity represented by the certificate, means of material identification (such as label, lot or marking), statement the material complies in all respects with the requirements of the cited specification, name, title and signature of person having authority to bind the manufacturer or supplier of the material, and results of tests required by the specification shall be submitted for all structural steel and high-strength bolts.

**475.2.2 Structural Shapes, Plates, and Bars:** Exposed surfaces of shafts, mast arms and risers shall be finished smooth and all exposed edges shall be neatly rounded to a 1/8" radius.

**475.2.3 Weld Inspection:** All welds shall be inspected according to the requirements shown in COP Traffic Signal Standard Details, and MAG Specifications.

#### **475.3 MATERIALS:**

**475.3.1 Pole Shafts:** Pole shafts shall be fabricated according to the requirements shown on the COP Traffic Signal Standard Details for types 1 through 15. Types 7 through 15 shall include either a blank top plate, 1' riser, 5' riser, 10' riser or a 20' riser as shown on the plans. The blank top plate or riser will be paid for separately.



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Hand holes in the base of the poles shall conform to the details shown on the COP Traffic Signal Standard Details. All welds shall be continuous and any exposed welds, except fillet welds, shall be ground flush with the base metal.

**475.3.2 Mast Arms:** Mast arms shall be fabricated according to the requirements shown on the COP Traffic Signal Standard Details for Types 9 through 15.

**475.3.3 Mast Arm Extensions:** Mast arm extensions shall be fabricated according to the requirements shown on the COP Traffic Signal Standard Details for Types 9 through 15. Mast arm extension configurations shall utilize the longest primary mast possible, to achieve mast arm lengths specified on the approved traffic signal plans.

**475.3.4 Damper:** The mast arms for pole Types 9 through 15 may require a damper as shown on the approved traffic signal plans. The damper shall be fabricated in accordance with the requirements shown on the COP Traffic Signal Standard Details.

**475.3.5 Risers:** The risers or blank top plates for pole shafts Types 7 through 15 shall be fabricated according to the requirements shown on the COP Traffic Signal Standard Details. In lieu of a riser on a pole shaft, a blank plate

The risers can accommodate single and dual luminaire mast arms, LED illuminated street name signs, wireless mesh radios or CCTV. Pole shaft Types 7, 9, 10 & 11 are restricted to 1' and 5' risers with a single luminaire mast arm shoe. Pole shafts Type 8 and 12 through 15 can accommodate all risers.

**475.3.6 Luminaire Mast Arms:** The mast arms for the luminaires and associated mounting hardware shall be fabricated as per COP Traffic Signal Standard Details for Types 7 through 15.

**475.3.7 Finish:** Pole shafts, mast arms, extensions, and luminaire mast arms shall be finished with a 2.5 mil powder coat (color will be confirmed by the Traffic Signal Shop). The visual appearance of the finish shall be uniform. Discoloration of the finish such as dark areas, dark streaks, dark rings, or transportation handling marks, which are considered excessive by the Traffic Signal Engineer or designee, shall not be allowed. Pole shafts, mast arms, and luminaire mast arms that have a finish unacceptable to the Traffic Signal Engineer or designee shall either be repaired or replaced to the satisfaction of the Traffic Signal Engineer or designee at no additional cost to the Department.

**475.3.8 Labeling:** All equipment and products shall be permanently labeled with the manufacturer's name, year of manufacture date, and equipment type.

**475.3.9 Grout:** Standard grout material will be 3:1 sand /cement mix. Standard grout shall be used for all installations where the bottom of the pole's baseplate is less than 3.5 inches above finished





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surface. Where the finished surface is angular to the baseplate, standard grout can be used if the longest gap is less than 4 inches.

If the measured gap exceeds requirements for standard grout, the applied grout shall be non-shrink, cementitious grout. Non-shrink grout materials shall be furnished premixed in a dry state including hydraulic cement, fine aggregate, and other ingredients as required for grout performance. Only the addition of mix water shall be required at the site of the work. The minimum compressive strength at seven days shall be 2,500 pounds per square inch and the minimum compressive strength at 28 days shall be a minimum of 5,000 pounds per square inch. Grout material will be 12:1 sand /cement mix.

### **475.4 CONSTRUCTION REQUIREMENTS:**

**475.4.1 Drawings:** The contractor shall submit copies of the detailed shop drawings to the Traffic Signal Engineer or designee for approval. Shop drawings shall be submitted sufficiently in advance of the start of the work to allow time for review by the Traffic Signal Engineer or designee and corrections by the contractor, if any, without delaying the work. Shop drawings shall give full, detailed dimensions and sizes of component parts of the structure and details of all miscellaneous parts, such as pins, nuts, bolts, and drains. Unless otherwise specified in the contract documents, shop drawings shall identify all materials that shall be used to produce each piece.

**475.4.2 Base Plates and Poles:** Poles will be installed and assembled in accordance with the manufacturer's specifications and as shown on the equipment sheet of the approved traffic signal plans and COP Traffic Signal Standard Details for types 1 through 15, ADOT standards for type 16 through 21, and these specifications.

All poles shall be plumbed to the vertical with all mast arms, signal heads, extensions, luminaires, and other devices indicated on the plans to be on the pole have been installed. When mast arms are bolted to the pole shaft, the mast arm end over the roadway shall adjust to the horizontal.

After erection and wiring, all the pole types will be grouted to seal the gap between the pole base and the foundation or sidewalk. The type of grout used will be determined by the size of the gap between the base plate and the finished grade of the foundation.

All scratches, mars, or abrasions to the finish of poles and mast arms will be repaired satisfactory to the COP Traffic Signal Engineer or designee prior to acceptance.

Sidewalks, curbs, gutters, pavement, base material, lawns, plants, and any other improvements removed, broken, or damaged by the contractor's operations shall be replaced or reconstructed with materials in accordance with these specifications. The replaced or reconstructed improvements shall be left in a serviceable condition satisfactory to the Engineer or designee and conform to these specifications where applicable.



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Where existing pole installations are to be modified, materials and equipment shall be used, salvaged, or disposed of as specified in Section 479 or as directed by the Engineer or designee.

If any poles are damaged by the contractor's operations, such repairs or replacements shall be at no additional cost to the Department.

**475.4.3 Mast Arms:** Pole mast arms, extensions, risers and luminaire mast arms shall be of the type shown on the equipment sheet of the approved traffic signal plans and shall be installed in accordance with the COP Traffic Signal Standard Details for types 7 through 15.

Mast arm bolts shall be pretensioned per plans. Mast arm bolts shall be adequately tightened to prevent loosening of nuts and to reduce the susceptibility to fatigue damage. Bolts may be pretensioned to values shown in plans using calibrated wrench, or by rotating the bolt 1/3 turn +/- 30 degrees past snug-tight. "Snug tight" is the tightness attained by a few impacts of an impact wrench or the full effort of a man using a spud wrench.

**475.4.4 Drilling of Poles and Mast Arms:** Wire entrance holes may be drilled for pole-mounted signals when a coupling is not available. Wire entrance holes will be drilled to provide connection to the traffic signal head through the lower bracket arm. Where drilling is required, the hole will be angled downward in poles. Drilled holes will be de-burred and all sharp edges removed.

Poles shall be drilled and tapped for mounting of signal equipment. The use of a welding torch is not authorized. New poles that are damaged by improper drilling of holes will be rejected. Written approval is required from a Signal Shop Supervisor or designee prior to any pole being drilled and tapped. New poles and mast arms that are damaged by improper drilling of holes will be rejected.

### **475.5 MEASUREMENT:**

Poles, mast arms, extensions, risers, dampers, and luminaire mast arms for traffic signals will be measured as individual units for each pole shaft, mast arm by length, extensions by length, risers by height, damper by each and each luminaire mast arm by type.

### **475.6 PAYMENT:**

The accepted quantities of pole shafts by type will be paid for at the contract unit price each. Payment shall be full compensation for the work, COMPLETE IN PLACE including grout, nuts, washers, and any other incidentals for installing the pole shaft.

The accepted quantities of mast arms by length will be paid for at the contract unit price each. Payment shall be full compensation for the work, COMPLETE IN PLACE including nuts, bolts, washers and any other incidentals for attaching the primary mast arm to the pole shaft.

The accepted quantities of mast arm extensions by length will be paid for at the contract unit price each. Payment shall be full compensation for the work, COMPLETE IN PLACE including attachment hardware and any other incidentals for attaching the extension to the primary mast arm.



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The accepted quantities of risers by height or blank top plate will be paid for at the contract unit price each. Payment shall be full compensation for the work, COMPLETE IN PLACE including nuts, bolts, washers and any other incidentals for attaching the riser or blank top plate to the top of the pole shaft.

The accepted quantities of luminaire mast arms by type will be paid for at the contract unit price each. Payment shall be full compensation for the work, COMPLETE IN PLACE including nuts, bolts, washers and any other incidentals for attaching the luminaire mast arm to the pole shaft or riser.



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### **SECTION 476** **ELECTRICAL POWER SERVICE PEDESTAL AND CONTROLLER CABINET**

#### **476.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing electrical Power Service Pedestal (PSP) and controller cabinets in accordance with the location and details on the equipment sheet of the approved traffic signal plan, COP Traffic Signal Standard Details, the requirements of these specifications, and the specifications of the utility company serving the location.

#### **476.2 MATERIALS:**

**476.2.1 Electrical Power Service Pedestal (PSP) Type-A & Type-B:** Each PSP system consists of the service pedestal cabinet, electrical service equipment, wiring, and wiring devices. Type-B PSP includes a battery backup system.

The PSP cabinet shall consist of the meter socket, circuit breaker panel, test bypass facilities, pedestal locking device, ground mount enclosure, transfer switch, generator receptacle and necessary fittings all of which shall conform to the requirements of the approved traffic signal plans for PSP type and the standard specifications listed below.

**476.2.1.1 General Requirements for PSP Type-A & Type-B:** The following specifications apply to both Types of PSPs.

1. The enclosure shall also comply with the current edition of the National Electrical Code (NEC), National Electrical Manufacturer's Association (NEMA), Electric Utility Service Equipment Requirements Committee (EUSERC), Caltrans Transportation Electrical Equipment Specifications (TEES) and Los Angeles County Traffic Signal Control Equipment Specifications (LACO TSCES) and shall be UL Listed.
2. The enclosure shall be dead front construction, vandal-resistant and rainproof NEMA type 3R.
3. Cabinets shall provide separate compartments for utility termination. All compartments shall be provided with stainless steel hardware for padlock and wire seals on the utility sections. There must be a permanent barrier separating the utility and customer areas. Utility doors, customer doors, and all covers shall be sealable with a gasket to seal out moisture.
4. The top and sides of the meter section shall be hinged to allow full unrestricted access to service the meter.



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5. PSP shall not have any exposed bolts, screws, or rivets which could be removed from the outside with common hand tools.
6. The meter socket shall be 4-jaw, 100 amps, 1-phase, 120/240 volt and complete with test blocks. Utility landing shall be rated 200 amps. All wiring shall be copper and rated 600-volt. PSP shall be set up for single phase, 120/240-volt, three (3) wire operation and a standard 10K AIC short circuit rating.
7. All 120-volt, 1-pole circuit breakers shall be of a common-trip type. No tandem or split circuit breakers will be accepted. Bryant, GE, Westinghouse/Cutler Hammer, and Crouse-Hinds/Murray manufacturer acceptable plug-in circuit breakers. All circuit breakers shall have an interruption capacity of 10,000 amperes.
8. Finish: Pedestal exterior finish shall be a powder coating which meets the standards of ASTM-B117 with the color being the manufacturer's standard pastel or mint green.

### **476.2.1.2 PSP Cabinet Assembly Type-A:** Provide tamperproof cabinets to provide 120/240 VAC 60-hertz electrical service.

1. Shall be constructed of zinc coated or hot dip galvanized steel, #12 gauge of the PSP body and frame, #14 gauge for the meter hood and removable covers.
2. Cabinet shall be a single width unit with a nominal dimension of 16 inches wide. 17 inches deep and 48 inches high.
3. All wiring shall be factory installed from the utility landing lugs to the 12-circuit customer load center complete with 100 amps back fed main circuit breaker.
4. Provide the following circuits in the Customer Load Center:
  - a. 30-amp, single pole breaker for the traffic signal.
  - b. 15-amp, single pole breaker for the luminaire.
  - c. 15-amp, single pole breaker for the "Illuminated Street Sign"
5. Customer load center shall be complete with dead front and all unused breaker spaces blanked out.
6. Ring for installation in concrete shall be included.
7. Utility termination lugs shall be AL/CU rated and sized for #6-250 MCM.

### **476.2.1.3 Cabinet Assembly Type-B:** Provide tamperproof cabinets to provide 120/240 VAC 60-hertz electrical service with battery back-up.

1. The Battery Back-up System (BBS) shall provide reliable emergency power to a traffic signal in the event of a power failure or interruption. That is, the BBS shall be capable of providing power for full run-time operation (UPS Mode) for an "LED-only" intersection (all colors, green, yellow, and red, INCLUDING PEDESTRIAN INDICATIONS) or flashing mode (Red Flash Mode) operation for an intersection using Red LEDs.



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2. The BBS shall include but not be limited to the following: inverter/charger, power transfer relay, batteries, a separate manually operated non-electronic bypass switch (see Figure 1 - BBS Block Diagram) and all necessary hardware and connecting wiring.
3. The underground electric service and the battery back-up system (BBS) shall be contained in a single pedestal enclosure, constructed of 0.125 aluminum (anodized, power coated or raw metal) or stainless steel with a minimum of 12-gauge wall thickness.
4. The dimensions of the cabinet shall be 35.00" wide by 55.00" high by 17.00" deep.
5. The underground feed service cabinet shall have metering compartment, underground fed utility, customer sections, and the BBS compartment.
6. The inverter/charger, power transfer relay and manually operated bypass switch shall be mounted inside the PSP cabinet.
7. Batteries shall be mounted on individual shelves with a minimum of four shelves inside the underground service cabinet. Each shelf shall have a minimum area of 228.6mm (9") X 431.8mm (17") in size and shall have a minimum clearance of 292.1mm (11.5") between the shelves. Each shelf shall be capable of supporting a minimum of 57kg (125lbs). The compartment shall be ventilated using louvered vents with filter and thermostatically controlled fan.
8. All hinged doors and covers shall use full-length "piano" hinges. The "piano" hinges shall be constructed of aluminum with stainless steel pins. The door shall be attached to the hinge by "plug welding". The hinge shall be attached to the cabinet with stainless-steel hardware.
9. Pad mount base (mounting ring) for concrete foundation shall be included with anchor bolts. Bolt hole pattern for mounting service cabinet to pad mount base shall be 30.75-inch-wide by 12.25-inch deep on center.
10. When viewed from the front, the underground service section shall be on the right half of the cabinet enclosure.
11. All provided wire for relay contact wiring for each set of NO/NC relay contact closure terminals shall not be less than 2 meters (6'6") of #18 AWG wire or longer if needed.
12. Meter Loop Assembly: The meter loop assembly shall be bonded and grounded in accordance with the requirements of these specifications.
13. Conductors: Conductor size and color shall be as specified on the traffic signal plan conductor schedule and in accordance with the requirements of these specifications. All electrical apparatuses shall be UL listed.
14. The load side conductors from the service meter shall terminate into a manual transfer switch (600 V rated 100 amp disconnect fused at 100 amp) located in the lower section of the cabinet in the customer side that shall feed the 100 amp, 2-pole, 120/240 volt, and 10K AIC main circuit breaker.



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15. The customer section shall have a 12 space/circuit load center with tin plated copper bus interiors for the metered loads.
16. The main 100-amp circuit breaker shall be a feed through with load side conductors terminated to main lugs on the panel buss.
17. The metered buss shall feed the UPS line side conductor with a 40-amp breaker.
18. The load side output from the UPS Charger Controller shall be terminated to a multi tap lug block that will Serve as the traffic signal controller terminal lug (labeled as traffic signal controller).

**476.2.2 Controller Cabinet Assembly:** Cabinet types and configurations shall be supplied as specified on the approved traffic signal plans, COP Traffic Signal Standard Details, and in accordance with these specifications.

The contractor shall supply an Econolite controller and Econolite controller cabinet with listed Integrated Ancillary Equipment:

1. Cobalt classic NEMA controller with latest revision of EOS firmware (includes ethernet module & USB port).
2. TS2/Type 1 "P" Plug-N-Go Cabinet: 8-phase Cabinet with two fans and thermostat (includes load switches, flasher, flash transfer relay, jumpers, detectors, 24VDC power supply, cabinet light, stop-time switch, cabinet filter, and all necessary equipment). The exterior of the cabinet shall be finished with a 2.5 mil high-gloss white powder coating.
3. EDI Bus Interface Unit - Part # - EDI-BIU700 (3 per cabinet)
4. EDI Malfunction Management Unit Smart Monitor Part # - EDI-MMU16LEip (1 per cabinet)
5. Ruggedcom Switch RST916C: Switch must be a “managed” switch, must be IP addressable, must have port speeds of (4) 10G Base-X/ 1000 Base-X SFP+ and (12) 10/100/1000 Base-T RJ45, must have serial and ethernet interface access ports, must be AC+ powered, must be operational in up to 80° C temperature range.

For reference purposes only, our local representative for the above cabinet and integrated equipment is <https://www.paradigmtraffic.com>.

The contractor shall deliver the signal controller and controller cabinet assembly to Traffic Signal Shop, 2141 E. Jefferson Street, Phoenix, AZ 85034 for final configuration testing and programming. The contractor shall coordinate the proposed delivery date and time with the Traffic Signal Supervisor or designee (602) 527-6369 at least 3 weeks prior to the contractor’s anticipated installation date.





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A 12" high cabinet extension ring shall be provided for each cabinet. Extension ring shall be bolted to the cabinet during installation in the field. The ring shall be made of 10 Ga. aluminum sheeting and finished with a 2.5 mil high-gloss white powder coating.

### **476.3 CONSTRUCTION REQUIREMENTS:**

**476.3.1 Electrical Power Service Pedestal:** The electrical power service pedestal shall be assembled and installed on a concrete foundation at the location shown on the approved traffic signal plan and in accordance with COP Traffic Signal Standard Details. Concrete foundation is a separate pay item.

**476.3.1.1 Provide Electrical Service:** The contractor is responsible for obtaining the electrical service provider's connection point (Power Source). Plans indicate the desired location of the Power Service Pedestal based on the best information available at the time plans were completed. The contractor will affirm and accommodate the point of connection.

At notice to proceed, the City of Phoenix Traffic Signal Supervisor will furnish the contractor with address numbers for all new electrical service pedestal points in the City of Phoenix.

The contractor shall be responsible for contacting the appropriate electrical service provider, arranging, scheduling, signing, and paying for agreements, line extensions and any other fees and arrangements necessary to energize the intersection traffic signal system or other controls in accordance with the plans.

In addition to the requirements of these Specifications, the contractor shall comply with all construction requirements of the electrical service provider regarding materials, inspection or other constructions, fees or scheduling necessary to energize the devices included in the plans.

Upon final acceptance, the contractor shall arrange for the transfer for all electrical service to the entity identified by the City of Phoenix.

**476.3.1.2 Installation of PSP:** Connect grounding buss bar to the cabinet foundation 5/8" grounding rod using a bare #4 AWG stranded copper wire. Attach the grounding wire to the ground rod with an appropriate connector.

Seal the service pedestal cabinet bases to the foundation using a commercial grade clear silicone sealer.

Use anchor bolts as required by the manufacturer of the cabinet, at least 5/8 inch in diameter by 18 inches long. Anchor bolts shall extend four (4) inches above the finished grade of the foundation.

**476.3.2 Controller Cabinet Assembly:** The contractor is responsible for delivering the controller cabinet and all related electronics to the City as noted above.





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The contractor shall adhere to the minimum cabinet foundation curing times (NO EXCEPTIONS) of seven (7) days when installing the controller cabinet extension ring and scheduling the City to install the controller cabinet.

Controller cabinet extension rings will be secured to the foundation with ½"-13 x 5" masonry stud anchors at a minimum. Masonry stud anchors are to be installed in accordance with the product manufacturer's instructions. Three inches of threaded stud will extend above the finished grade of the Controller Cabinet foundation.

City of Phoenix shall install the controller cabinet to the controller cabinet extension ring previously installed by the contractor to the cabinet foundation. City of Phoenix will terminate field wiring after all field circuits have been proofed for proper operation.

**476.3.3 Foundation Curing Time:** Minimum cabinet foundation curing times (NO EXCEPTIONS) before loading is seven (7) days.

### **476.4 MEASUREMENT:**

Electrical Power Service Pedestals and Controller Cabinets will be measured as a unit for each type installed.

### **476.5 PAYMENT:**

The accepted quantities for each electrical power service pedestals, by type, will be paid for at the contract unit price. Payment shall be full compensation for the work, COMPLETE IN PLACE including all electrical components, mounting hardware, ground wire, and any incidentals necessary to complete the work.

The accepted quantities for the installation of the controller cabinets measured as provided above will be paid for at the contract unit price. Payment shall be full compensation for the work, COMPLETE IN PLACE including delivery of the controller cabinet and electronics, and the supply installation of controller cabinet extension ring, mounting hardware and incidentals necessary to complete the work.



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### SECTION 477

#### TRAFFIC SIGNAL HEADS AND MOUNTINGS

##### **477.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing approved vehicular and pedestrian traffic signal indications and mounting assemblies in accordance with the types and locations shown on the equipment sheet of the approved traffic signal plan, COP Traffic Signal Standard Details, and the requirements of these specifications.

##### **477.2 MATERIALS:**

Provide traffic signal head assemblies consisting of Light Emitting Diode (LED) vehicle signal display sections, directional louvers, and pedestrian signal heads as well as associated mounting hardware for pole or mast arm mounting, as required.

**477.2.1 Vehicular Traffic Signal Heads:** Vehicular traffic signal heads shall be assembled of standard 12-inch (300mm) lens size signal sections with the number of sections or combination of sections specified on the equipment sheet of the approved traffic signal plan, COP Traffic Signal Standard Details and the requirements of the Manual on Uniform Traffic Control Devices. The optical performance and design of traffic signal heads shall conform to the most current requirements of the Institute of Transportation Engineers Standards for Vehicular Traffic Control Signal Heads (VTCSH).

##### **477.2.1.1 Traffic Signal Heads:**

1. Provide 12-inch traffic signal head assemblies that consist of individual sections of the number and configuration shown on the approved traffic signal plans, fastened together to produce a single unit.
2. Provide 12-inch signal heads with a 7 to 10-inch tunnel visor, a one-piece 5-inch aluminum non-louvered back plate, and an LED module for each section.

##### **477.2.2.2 Section Housing:**

1. Provide one-piece, polycarbonate housings for each section complete with a top, a bottom, and sides, and with black color impregnated into the material.
2. Equip each section housing with a rectangular polycarbonate door meeting the minimum requirements of ASTM B 85.
3. Provide two hinge lugs on the left of each housing section and with latch screw lugs on the right side of the housing.
4. Provide openings in both the top and bottom of the housing to accommodate standard 1 1/2-inch pipe fittings.



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- a. Provide a Shurlock boss in the bottom opening having 72 clean, sharp teeth that provide full engagement, angled at 90 degrees, and having a depth of 5/64 inch.
  - b. Provide two indentations in the top and bottom opening designed to receive a Shurlock ring to provide positive positioning of the head when mounted from a mast arm or span wire hanger.
  - c. Provide a means of positive alignment when indexing each section by using mating bosses and recesses.
  - d. When used with Shurlock fittings, the radial angular grooves of the Shurlock boss, must provide positive positioning of the entire signal head and eliminate rotation or misalignment of the signal.
5. Provide each housing section with a minimum of four mounting points, two on each side, to secure the back plate to the signal head.

### **477.2.2.3 Housing Door:**

1. Provide housing doors consisting of a one piece, polycarbonate housing door for each signal section with black color impregnated into the material.
2. Provide two hinge lugs on the left of each door and latch paws on the right side of each door.
3. Provide hinge pins that are easily removable without the need for special tools.
4. Provide a corrosion resistant, stainless steel latch screw and wing nut on the right side of the housing to allow opening and closing the signal door without the use of any tools.
5. Form the inside of the door with a gasket groove and provide a weather-proof and mildew resistant resilient polyethylene gasket which seats against a raised bead on the housing when the door is closed to make a positive weatherproof and dustproof seal.
6. The housing door shall contain 4 lens clips per door to hold the LED lens into the door frame against the gasket securely. The LED lens shall be removable using the lens clips without the need of any hand tools.
7. On the outer face of the door and equally spaced about the circumference of the lens opening, provide four tapped holes to accommodate the signal head visor.
8. Provide four 18-8 Type 304 stainless steel truss head screws to attach the signal head visor.

### **477.2.2.4 Signal Head Visors:**

1. Equip each signal place with a tunnel style (open bottom) visor that is approximately 7 to 10-inches long.
2. Provide visors blanked, formed, and welded from .050-inch-thick 3105-H25 aluminum alloy.



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3. Design and fabricate the visors with attaching ears (slotted tabs) to facilitate installation.
  - a. Construct the visor so it can be installed or removed from the signal head without removing the attaching screws or opening the housing door.
  - b. Construct the visor so the axis of the visor does not deviate more than 3.5 degrees or less than 3 degrees downward from horizontal.

### **477.2.5 Light Emitting Diode Vehicle Signal Display Sections:**

1. Provide LED traffic signal modules meeting all the requirements identified in the most current LED Purchase Specification of the Institute of Transportation Engineers, except as may be herein listed.
  - a. Provide single, self-contained LED signal module devices with an integral power supply in the sealed LED module.
  - b. Affix a manufacturer's label that includes all the information listed in the most current ITE LED Specification and the date of manufacture to each LED module.
  - c. Construct the LEDs with an AlInGaP substrate.
2. Provide a weather tight module that fits securely in the housing and connects to the traffic signal head wiring terminal block.
  - a. Design LED traffic signal modules to fit traffic signal housings that meet the specifications established herein.
  - b. Design the terminal block only for crimped on terminal connectors.
3. LED Environmental Requirements: The LED module shall be rated for the -40° C (-40° F) to +74° C (164° F) temperature range.
4. LED CERTIFICATION: The contractor shall supply an Intertek report and Certificate of Compliance of the current ITE LED Vehicle Traffic Signal Module or Pedestrian Traffic Signal Module Specification with the material submittal.
5. LED Module Electrical Requirements: The LED module is to be connected to the terminal block using two color-coded copper wires. The wire is to be No. 20 AWG with 30 mil jacketed insulation. The wire is to be rated for 600-volt AC. The insulation is to be rated for 105° C (220° F).
  - a. Provide a 22 – 18 AWG female disconnect with a flanged spade terminal with a fork for each wire.
6. LED Dimming: All LED modules are not to be equipped with dimming circuitry.
7. LED Module Compatibility- All LED are to be compatible with approved load switches and conflict monitors. The contractor will include in the material submittal a list of all



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control equipment known to be incompatible with the submitted LED module. This list is to include all known equipment as well as that employed in this contract

8. Wiring: Each LED module is to have wiring color coded. The color code will relate to the display provided by the module as follows:

<u>Function</u>	<u>Color</u>
Common (Neutral)	White
Red Ball or Arrow Driver	Red
Yellow Ball or Arrow Driver	Yellow
Green Ball or Arrow Driver	Green

### **477.2.2.6 Terminal Blocks:**

1. Each complete signal head will be equipped with a 6 position, 12 terminal, barrier type, phenolic terminal strip with 4 – quick connects per port that accepts blade connectors.
2. The terminal blocks are to be in the center section or the section just below the plumbizer of vertically arrayed signal head assemblies and in the red ball section of 5-section mast arm mounted side by side arrayed signal head assemblies.
3. The white, red, yellow, and green signal section leads will be attached to the same side of the terminal strip.

### **477.2.2.7 Colors and Finishes:**

1. Signal Head Color: All Vehicle signal heads are to be color impregnated. Impregnate a black color into the material of all polycarbonate surfaces, including the inside and outside of the signal housing, the door, and the visors.
2. Back Plate Finish: The back plates are to be finished with a low gloss two-part high solids enamel paint with ultraviolet inhibitors. Powder coating is an acceptable alternative.

**477.2.2.8 Banding:** Banding employed for mounting traffic signals, pedestrian signals and other traffic control equipment for mast arm or pole mounted devices is to be of stainless steel a minimum of .030-inch-thick by 1/2 inch wide.

**477.2.2.9 Mounting Hardware:** The contractor shall submit cut sheets for all mounting hardware as part of their material submittals.

1. For mast arm mounted signal head assemblies, install an elevator plumbizer below the red section, or in the center of a 4 - section, of the signal head as shown on the COP Traffic Signal Standard Details.
2. When signal head assemblies are equipped with an elevator plumbizer, provide the top and bottom sections of the assemblies with a gasketed closure in the 1 ½ -inch openings.



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3. Cast elevator plumbizers from steel or aluminum and provide smooth castings or machine the plumbizer to remove all sharp edges.
4. When required, equip the signal head with a mast arm mounting bracket assembly consisting of a banded cable pole plate and a 2-inch support tube designed for rigidly mounting a signal head equipped with an elevator plumbizer on a mast arm.
5. For pole mounted signal heads, provide each signal head assembly with a set of mounting brackets consisting of the following:
  - a. Two 1 1/2-inch aluminum pipe elbows each with a serrated surface having 72 teeth.
  - b. Two 1 1/2-inch aluminum chase nipples with 2 1/2-inch hex heads.
  - c. Two 12-inch Schedule 40 aluminum pipe arms.
  - d. Two band-on style pole brackets.
6. Include additional aluminum nipples and steel lock nuts as necessary to complete the assembly as shown on the COP Traffic Signal Standard Details.
7. Finish the mounting hardware for mast arm or pole mounting with paint or powder coating in a high gloss black.

### **477.2.3 Directional Louvers:**

1. Where shown on the plans, directional louvers with a 3-degree cutoff shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The cylinder and vanes shall be fabricated from 5052-H32 aluminum alloy. The outer cylinder and the vanes shall be 0.032 inches minimum thickness, and the vanes shall be 0.016 inches minimum thickness.
2. Tunnels requiring Louvers shall have a full tunnel.
3. Programmable louvers may be required.

**477.2.4 Pedestrian Signal Head:** The optical performance and design of pedestrian signal heads shall conform to the requirements of the Institute of Transportation Engineers Standards for Pedestrian Traffic Control Signal Indications (PTCSI).

Provide pedestrian signal head assemblies consisting of a signal housing with a door assembly and visor, a Countdown Light Emitting Diode (LED) pedestrian display module and associated mounting hardware. When the housing, door assembly and visor, and LED display module are fully assembled, they must provide a weatherproof and dustproof enclosure that meets or exceeds current ITE standards.

### **477.2.4.1 Signal Housing:**

1. Provide a single section aluminum pedestrian signal housing.



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2. Signal Housing Dimensions (Nominal): 19 inches wide by 18 1/2 inches high by 8 1/2 inches deep.
  - a. Tolerance: Plus or minus 1/2 inch.
  - b. Dimensions include the visor and door.
3. Integrally cast two equally spaced mounting lugs into the top and bottom of the housing with stainless steel pins and wing nut assemblies to serve as the door hinges and latches.
4. Cast standard 1-1/2-inch openings, complete with reinforcing ribs for transferring stress.
5. Cast a standard signal hardware configuration having 72 serrated teeth for maintaining a positive orientation of the signal face into the bottom opening.

### **477.2.4.2 Door Assembly:**

1. Provide a door assembly consisting of a die cast, one piece, corrosion resistant aluminum alloy frame with two cast lugs on the bottom and two cast latch slots on the top of each door.
2. Attach the door to the housing using stainless steel detent spring pins on the bottom and stainless-steel captive wing nut and eyebolt assemblies that drop into the latch slots on the top.
3. Design the door assembly to open from the top and hinge down for servicing without the use of any tools.

### **477.2.4.3 Visor:**

1. Equip the door with an integral blank out egg crate visor fabricated from black impregnated ultraviolet stabilized and flame-retardant polycarbonate.
2. Design the egg crate to consist of a series of nominally 0.030-inch-thick material formed into one-inch squares rotated 45 degrees to form diamonds and which are also bisected by 1-1/2 inches deep horizontal louvers.
3. Provide a substantial exterior framework that allows the visor to be securely attached to the doorframe with stainless steel screws.

### **477.2.4.4 Light Emitting Diode (LED) Pedestrian Display Module:**

1. Provide a Light Emitting Diode (LED) pedestrian display module with 9" numerals as per MUTCD, capable of displaying international symbols with count down capabilities.
2. Provide LED international symbols of a "Hand", a "Man", and Countdown numerals, sized and colored to conform to the latest ITE (PTCSI) standards.
  - a. Provide filled symbols and not outlined symbols.
  - b. Blackout the entire area around the legend so that light does not project through any area other than the legend.
3. Construct the LEDs with an AlInGaP substrate.





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4. Provide an LED countdown timer that detects the "DON'T WALK" cycle and begins its countdown based on that duration and that blanks out the countdown display when a timing change occurs.
5. Fit the module lens with a one-piece EPDM gasket to provide a waterproof and dustproof seal when the door assembly is closed across the housing surface, into the top and bottom of the housing.
6. Optically, the pedestrian signal head shall display brightly and uniformly, the alternate symbol messages "HAND" in Portland orange, "COUNTDOWN NUMERALS" in Portland orange and "WALKING PERSON" in lunar white under all ambient light conditions. The message symbols shall not be seen (blank-out) when the message symbol is not energized.
7. The lunar white and Portland orange LED, solid state controls, and transformers for energizing the LED shall be encased in a plug-in module. The HAND and WALKING PERSON symbol message lens shall be ultraviolet stabilized polycarbonate. The HAND and WALKING SYMBOL message shall be full indications only.

**477.2.4.5 Mounting Hardware:** The contractor shall submit cut sheets for all mounting hardware as part of their material submittals. For each pedestrian signal head assembly, provide a set of mounting brackets consisting of the following:

1. Two 1 1/2-inch aluminum pipe elbows each with a serrated surface having 72 teeth.
2. Two 1 1/2-inch aluminum chase nipples with 2 1/2-inch hex heads.
3. Two 12-inch Schedule 40 aluminum pipe arms.
4. Two band-on style pole brackets.
5. Include additional aluminum nipples and steel lock nuts as necessary to complete the assembly as shown on the Plans.

**477.2.4.6 Pole Plates:**

1. Provide 3-inch wide by 5 3/8-inch-long band-on style aluminum pole plates with a 1 1/2-inch NPT center hole.
2. Provide the pole side of the plate with a curvature of approximately 2 3/16-inches and a chord length of approximately 3 inches.
3. Machine, ream, or cast the inside and outside of each pole plate, elbow, chase nipple, and pipe arm to remove all sharp edges.

**477.2.4.7 Finish:**

1. Prior to applying an electrostatic, oven cured powder coat finish, sandblast, clean, and chemically seal all exterior surfaces of the pedestrian head housing, door frame, and the side of the pole mounting hardware.





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2. Finish the housing, door frame, and mounting hardware with a high gloss black, and the visor frame with a low luster flat black.

### **477.3 CONSTRUCTION REQUIREMENTS:**

Vehicular and pedestrian traffic signal heads shall be mounted utilizing mounting hardware specified to either a horizontal pole or vertical mast arm in accordance with the mounting hardware manufacturer's specifications.

#### **477.3.1 Wiring for Vehicular Traffic Signal Heads:**

1. Traffic signal heads will be wired from the terminal block in the signal head to the point of connection in the hand hole at the base of the traffic signal pole plus an additional 16 inches beyond the hand hole with a continuous length of IMSA 19-1 cable. For size and number of conductors see wire code tables in COP Traffic Signal Standard Details.
2. The white conductor inside the IMSA cable from each signal head shall be connected to the white #10 neutral conductor in the hand hole at the base of the traffic signal of the pole.
3. Connections to the terminal block in the signal heads will be made with a manufactured crimp on connector of appropriate size.
4. Cables for mast arm signal heads will pass through de-burred 1" installer drilled cable entrances. All others installer drilled de-burred cable entrance holes will be 1/2-inch

#### **477.3.2 Wiring for Pedestrian Signal Heads:**

1. Pedestrian signal heads will be wired from the terminal block in the pedestrian signal head to the point of connection in the hand hole at the base of the traffic signal pole plus an additional 16 inches beyond the hand hole with a continuous length of 3 conductor IMSA 19-1 cable. For size and number of conductors see wire code tables in standard details. The white conductor inside the IMSA cable from the pedestrian head shall be connected to the white #10 neutral conductor in the hand hole at the base of the traffic signal pole.
2. Connections to the terminal block in the signal heads will be made with a manufactured crimp on connector of appropriate size.
3. Cable from pedestrian signal heads will pass through a de-burred 1/2-inch installer drilled cable entrance hole.

### **477.4 MEASUREMENT:**

Vehicular traffic signal heads will be measured as a unit for each type of vehicular traffic signal head installed.

Directional louvers will be measured as a unit for each louver installed in an individual signal head section, as specified on the approved traffic signal plans.



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Pedestrian signal heads will be measured as a unit for each pedestrian signal head installed.

### **477.5 PAYMENT:**

The accepted quantities of vehicular traffic signal heads by type, measured as provided above, will be paid for at the contract unit price. Payment shall be full compensation for the work, COMPLETE IN PLACE, including visors, louvered back plates, LEDs, mounting hardware, wiring to the hand hole in pole shaft, and incidentals necessary for the fabrication and installation of the vehicular traffic signal heads. Directional louvers contained in the vehicular traffic signal head shall be paid for separately.

The accepted quantities of directional louvers, measured as provided above, will be paid for at the contract unit price. Payment shall be full compensation for the work, COMPLETE IN PLACE, including mounting hardware, aiming of directional louver and incidentals necessary for the installation into the vehicular traffic signal heads.

The accepted quantities of pedestrian signal heads, measured as provided above, will be paid for at the contract unit price. Payment shall be full compensation for the work, COMPLETE IN PLACE, including visors, LEDs, mounting hardware, wiring to the hand hole in pole shaft, and incidentals necessary for the installation of the pedestrian signal heads.



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### SECTION 478 TRAFFIC SIGNAL INTERSECTION STREET LIGHTING

#### **478.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing LED luminaires for intersection lighting at traffic signals in accordance with the location shown on the equipment sheet of the approved traffic signal plan and the requirements of these specifications.

#### **478.2 MATERIALS:**

**478.2.1 General:** Intersection lighting materials shall conform to the type and location of the luminaire as indicated on the equipment sheet of the approved traffic signal plan. All luminaires shall be supplied with an individual photoelectric cell. The luminaire shall be supplied with a seven-pin photocell receptacle. Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures.

The luminaire shall be LED, and shall be capable of operating on primary voltages of 120 to 277 volts, 60 Hz, AC. The luminaire shall be of the 90° cut-off type and gray or bronze in color as specified on the plans. The light distribution pattern shall be Type 3 Medium with a 2,700K color temperature in accordance with the COP Street Lighting Guidelines. Luminaires supplied shall be on the COP approved luminaire list. All luminaires installed on traffic signals shall be of arterial roadway standards.

**478.2.2 Luminaire Housing:** The luminaire housing shall be fabricated from a corrosive resistant metal material and have a baked-on enamel finish.

**478.2.3 Photo Electric Control (PEC):** The photocell (PEC) shall be fail-on, rated at 105-305volt, 60 Hz AC 1,800 volt-ampere. The operating temperature range shall be from -40° F to +158° F and 100 percent relative humidity. The PEC shall be a conventional glass-faced hermetically sealed 1/2-inch cell. A 3-5 second time-delay shall be incorporated into the PEC circuit to prevent cycling at night by transient lights which might be focused on the PEC.

The PEC shall turn-on at  $1.5 \pm 0.2$ -foot candles and turn-off at  $1.5.1 \pm .25$ -foot candles. The PEC shall be UL listed for rain-tight applications. A built-in 40,000 Amp surge protector shall be provided to protect the PEC from lightning induced and line voltage transients.

The PEC shall incorporate a twist lock mount with a Neoprene gasket meeting ASTM D 1056 specifications. The control shall have an operating life of 20 years.

The cover shall be made of polypropylene with UV inhibitors.



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**478.2.4 Luminaire Wire:** contractor shall provide an IMSA 19-1 Cable, 3 conductor, #16 solid or stranded with a PVC outer jacket from the luminaire to the point of connection in the junction box. Cable to be identified and wired as shown conductor table.

### **478.3 CONSTRUCTION REQUIREMENTS:**

Luminaires of the size specified shall be furnished and installed at the locations shown on the approved traffic signal plan. Unless otherwise specified, the luminaire shall be adjusted to the horizontal. All wiring shall be in compliance with the NEC, the requirements of COP Traffic Signal Standard Detail Sheets and as shown on the plans. The intersection lighting shall be wired from the luminaires directly to the power service pedestal on an individual circuit breaker.

The PEC shall be installed so the photo-eye faces the North.

### **478.4 MEASUREMENT:**

Luminaires will be measured as a unit for each luminaire furnished and installed by color of the luminaire housing.

### **478.5 PAYMENT:**

The accepted quantities for luminaires by color of luminaire housing, measured as provided above, will be paid for at the contract unit price, each, which shall be full compensation for the supply and installation of the item, COMPLETE IN PLACE, including any wiring from the luminaire to the junction box, photocell, and any other incidentals necessary to complete the work.



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### SECTION 479 ELECTRICAL CONDUCTORS

#### **479.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing single electrical conductors and cables for traffic signals and intersection lighting in accordance with the equipment sheet of the approved traffic signal plan and requirements of these specifications.

#### **479.2 MATERIALS:**

Wire and cable shall be UL listed and rated at 600 volts unless otherwise specified. The UL label shall be present on each reel, coil, or container of wire or cable. When requested, the contractor shall submit to the Engineer or designee the manufacturer's written certification that the product conforms to the requirements of these specifications.

All wire nuts shall be UL listed (Ideal underground model numbers 60, 64, and 66, or approved equal). Wire nuts shall be pre-filled with silicone-based sealants for moisture and corrosion, UL listed to 486D for direct burial, and a shell rated for 105 C.

All other wiring devices shall be UL listed.

Conductor sizes shall be as specified on the wiring sheet of the approved traffic signal plan. Conductor insulation color shall be in accordance with the COP Traffic Signal Standard Details.

**479.2.1 Single Electrical Conductors:** The wire shall be annealed copper and shall be uncoated unless otherwise specified. Unless otherwise indicated, the wire shall be solid for number 10 AWG, conforming to the latest requirements of ASTM B 3 for annealed bare copper wire. Conductors for sizes number 8 AWG and larger diameter wire shall be stranded and shall conform to ASTM B 8 for Class B stranding, unless otherwise specified, the conductors shall be insulated with THW grade thermoplastic compound and shall meet the requirements of UL 83. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment of coating. The insulation thickness shall conform to the requirements of the NEC. Conductor insulation shall be a solid color unless otherwise specified. The color shall be continuous over the entire length of the conductor.

**479.2.2 Shielded Loop Detector Cables:** Loop detector lead-in shielded cables shall be 6-conductor AWG. #18, stranded, twisted, three pair, tinned copper, polyethylene insulated cable with a polyethylene jacket, rated at 600 volts and 140° Fahrenheit and shall be in conformance with IMSA Specification 50-2.

**479.2.3 IMSA Cables:** IMSA cables shall be copper conductors for use in underground conduit or as aerial cable conforming to IMSA Specification 19-1. Wire insulation color assignment shall



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be in accordance with COP Traffic Signal Standard Details. All cable except 25 and 42 conductors follows IMSA 19-1 lay up for cable construction.

Construction Details:	
Total Number Conductors	3, 5, 7, 25, 42
Awg	16
Stranding	Stranded
Conductor Material	Bare copper
Nominal Cond. Resistance Insulation Material	Per IMSA 19-1 table 3.1.1 90C Wet/Dry XHHW-2 type bulletinized compound per table 2 of UL Class XL compound
Insulation/Dielectric Thickness	.030"
Color Code	Per IMSA 19-1 table 5.1
Conductor Assembly	Per IMSA 19-1 section 6
Fillers	Per IMSA 19-1 section 7
Tape Material	Clear Mylar min 10% overlap
Final Jacket Material	90C Black Sunlight Resistant Direct Burial Polyvinylchloride per IMSA 19-1 section 9.1
Nominal Thickness	Per IMSA 19-1 table 9.3
Jacket Color	Black
Ripcord	YES
Print:	
Indent	YES
Sequential Foot Marks	YES
Print Legend (Indent Print)	"MANUFACTURER" 19-1 90C High Temp 600v (YYYY) "yyyy= current year"
Electricals:	
Operating voltage	600v
Conductor Rating	ASTM B-3, B-8
Applicable Standards:	
Certifications	UL/ETL
IMSA	Type 19-1 1997
ROHS Compliant	YES



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The IMSA 19-1 cable shall be provided with the number and size of conductors as specified on the plans. All cable shall be stranded copper.

All 42 conductor IMSA Spec 19-1 cables shall be constructed as follows: Two (2) layers of 21 conductors AWG. #16 stranded. Each layer will contain 21 color conductors per IMSA Spec 19-1, Table 5.1 and separated by a clear Mylar tape. The colors and tracers shall be permanent and an integral part of the insulation and shall not be painted, surface coated or adhered to the surface. Ink strips are unacceptable. Conductor insulation colors shall be standard IMSA colors. Cable conductor color, phase, and interval assignments shall be in accordance with COP Traffic Signal Standard Details.

**479.2.4 EVP Detector Cable:** The EVP detector cable shall be a three conductor AWG. #20 stranded, tinned copper insulated wires with an AWG #20 tinned copper uninsulated drain wire. The insulation for the three wires shall be PVC, of the following colors, blue, orange and yellow. The cable shall have a black PVC outer jacket rated for 600 volts.

**479.2.5 EVP Confirmation Light Cable:** The EVP confirmation light cable shall be a two conductor AWG #18 stranded, tinned copper insulated wires. The insulation for the two wires shall be color coded PVC. The cable shall have a gray PVC outer jacket rated for 300 Volts.

**479.2.6 Category 5e Cable:** The Category 5e (Cat 5e) cable shall meet the following requirements:

1. TIA/EIA Cat 5e 350MHz Four-pair Network Cable
2. 24 AWG Solid Copper Conductors
3. Meets or Exceeds TIA/EIA-568-B.2 Standards
4. UL Rated for Permanent Installation
5. 3 Pairs FEP/ 1 Pair Polyolefin Insulation
6. PVC Jacket

### **479.3. GENERAL WIRING REQUIREMENTS:**

Conductors and cables shall be pulled into runs in a smooth continuous manner, avoiding contact with sharp objects that might damage the insulation. Approved lubricants shall be used for inserting conductors in conduit. Before installation, conductors' ends shall be taped for moisture protection until connections are made. Approved splices are permitted in pull boxes, pedestals, pole hand holes, and cabinets.

Conductors and cables shall have a minimum of 36 inches of slack above the top of the pull box.

**479.3.1 Wire Tagging:** Individual conductors for each vehicular and pedestrian phase group shall be secured together by two layers of plastic electrical tape and tagged with an approved wire I.D. marker as shown on the COP Traffic Signal Standard Details. Cables for each vehicular and



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pedestrian phase group shall be wrapped with two layers of plastic electrical tape and tagged with an approved wire I.D. marker as shown on the COP Traffic Signal Standard Details. Wires and cables shall be individually marked in all cabinets, pole hand holes and in pull boxes as per COP Traffic Signal Standard Details.

**479.3.2 Conductor Splices:** Splices shall be made utilizing wire nut connectors. Splices in underground junction boxes shall be made with silicone-filled wire nut connectors. Wire stripping length and wire size combinations shall be in accordance with the manufacturer's instructions supplied with the wire nut connector. Soldered connections will not be permitted except for loop detection wiring system. All phases shall be spliced in pull boxes to complete the circuit between the signal indication and the signal cabinet. Unused phase conductors shall not be spliced at a junction box creating an open hot circuit at the other end of the conductor. All IMSA multi-conductor cables shall be taped with 2 layers of black electrical tape where sheathing is stripped for splicing.

Detector cables shall contain no splices and run continuously from the detection system to the control cabinet.

**479.3.3 Bonding and Grounding:** All metallic enclosures such as cabinets, pedestals, poles, conduit, and cable sheaths shall be bonded to form a continuous grounded system. Non-metallic portions of the system, such as PVC conduit, shall have a No. 10 AWG bare solid copper bond wire installed with suitable connections to form a continuous grounded system. The individual grounding components are paid for separately as incidental to the pay item being grounded (conduit & foundations).

**479.3.4 Intersection Splicing:** Conductors and cables shall be spliced in accordance with Section 478.3.2. Intersection splicing shall be a single pay item to connect all conductors and cables as well as creating a bonded grounded system. The bonded grounded system shall form a complete system from the PSP ground rod to the control cabinet buss bar, and from the control cabinet buss bar to the hand hole on the pole. Any grounded device on the pole shall have their ground connected to the grounding system. All terminations in the traffic signal control cabinet shall be performed by COP staff.

### **479.4 MEASUREMENT:**

Conductors for traffic signals and intersection lighting will be measured by linear foot of wire installed from the hand hole at the base of a traffic signal pole to the pull box, between pull boxes, and between the pull boxes and controller cabinet or power pedestal including any additional cable required at the junction box and at the cabinet.

Cable runs that are continuous above the handhole shall have the additional footage above the handhole to the device, coils in junction boxes, and additional cable required in the cabinet added to the total length of cable supplied.





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Intersection Splices in wires and cables not covered in other pay items, will be paid as a lump sum per intersection. These are typically found at the hand holes in the base of traffic signal poles or in pull boxes.

### **479.5 PAYMENT:**

Conductors, measured as provided above, will be paid for by the unit price bid by type of wire or cable, which price shall be full compensation for the item, COMPLETE IN PLACE including any slack in the wire or cable, installation of the wire or cable in conduit or inside a pole, and any other incidentals needed for installation.

Intersection Splicing will be paid as a lump sum per intersection, which price shall be full compensation for the item, COMPLETE IN PLACE including wire nuts, colored marking tape, and any other incidentals needed to complete the wire splicing, tagging, or grounding system.



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### SECTION 480

#### REMOVAL AND SALVAGE OF EXISTING TRAFFIC RELATED FACILITIES

##### **480.1 DESCRIPTION:**

It is the purpose of this section to provide information necessary for the completion of the removal and disposal of traffic signal equipment and materials as shown on the approved traffic signal plan to be removed.

##### **480.2 CONSTRUCTION REQUIREMENTS:**

**480.2.1 General:** All removals shall be done in accordance with Section 350, as shown on the approved traffic signal plan, and as detailed below. Any item noted on the approved traffic signal plan or these Specifications to be salvaged shall be delivered to the COP Traffic Signal Shop or as directed by the Engineer or designee. Delivery to the Traffic Signal warehouse shall include unloading the salvaged materials at a designated warehouse location by the contractor using the contractor's own equipment. Two working days (forty-eight hours minimum) in advance of the intended date of delivery, the contractor shall coordinate the proposed date, time, and items to be delivered to the COP Traffic Signal Shop (602) 262-6021. Warehouse hours for receiving deliveries are 8:00 am – 2:00 pm Monday through Friday. The address for the City warehouse is:

City of Phoenix Traffic Signal Shop  
2141 E. Jefferson St.  
Phoenix, Arizona 85034

Remove, deliver and unload in good condition any existing equipment identified by the COP as salvageable to the location designated by the COP. Dispose of all signal hardware identified by the COP as non-salvageable or scrap material. Non-salvageable material becomes the property of the contractor. The cost of providing for its proper storage and ultimate disposal to meet Federal or State requirements is incidental to the payment for the removal of the item.

Deliveries of salvaged or obsolete traffic signal equipment to the location designated by the COP will be done in accordance with a schedule submitted to and approved by the COP no less than 24 hours in advance of the action.

Material will be inventoried upon delivery and identified with the intersection from which the material was removed.

**480.2.2 Signal Poles:** For signal poles, remove, transport and unload mast arm poles, mast arms, poles and posts identified as salvageable by the COP as described in these Specifications. Disassemble mast arm poles and mast arms before transporting. Leave hand hole covers in place.



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Remove all signal mounting hardware from poles and mast arms before transporting. Attaching hardware and anchor bolt nuts and washers may be bulk packed for delivery.

**480.2.3 Controller Cabinet and Power Pedestal:** For controller cabinets including internal electronics and power pedestals identified as salvageable by the COP the field wiring will be disconnected, and all loose electronics in the control cabinet will be removed. Both the controller cabinet and power pedestal may be ground mounted or pole mounted. The controller cabinet, loose electronic devices, and power pedestals will be transported and unloaded as described in these Specifications.

**480.2.4 Foundations:** Foundations within the ultimate curb and gutter of the roadway shall be part of roadway plans and removed in accordance with Section 350. The approved traffic signal plans will identify foundations to be removed in accordance with this section. Existing Type “A” poles, pedestrian push-button poles, power pedestals, and controller cabinets will be removed in their entirety as well as any other foundations less than 42 inches in depth. Deeper foundations such as those for mast arm poles must be removed to a minimum of 10 inches below the finished grade of the sidewalks or landscaping. Voids created by the removal of the foundations will be backfilled with natural material compacted to match the density of the surrounding material.

**480.2.5 Incidental Traffic Items:** This item provides for the removal of all incidental traffic items some of which will be salvageable such as signal heads, pedestrian heads, luminaires, pedestrian push buttons and non-salvageable such as junction boxes, conduit, wiring, loops, and loop lead-ins. Prior to removal of any items, the contractor shall meet with COP Traffic Signal Engineer or designee to identify specific salvageable materials which will be transported to the location noted above. Items identified as non-salvageable, shall become the property of the contractor and disposed of in accordance with applicable State or Federal regulations.

Junction boxes rendered obsolete by the signal construction will be removed and disposed of by the contractor. Conduit runs shallower than 24 inches will be removed. Existing conduit runs with 24 inches or more of cover (when compared to the finished grade) may be abandoned in place. The contractor will remove all wire and cable from conduits to be abandoned in place. The contractor will dispose of all conduit, wire, and cable removed. For loops and loop lead-ins in saw cut they are to be abandoned in place. Conduit for twisted pair loop lead-in must be cleared of wire, and may be abandoned in place or removed, at the contractor’s choice. If removed, any damage to existing pavement that is to remain shall be repaired at the contractor’s expense.

### **480.3 MEASUREMENT:**

Removal of identified existing facilities specified in 474.2.2 (Signal Poles) and 474.2.3 (Cabinets and Power Pedestals) will be measured on an “each” basis by type of facility removed.

The method of measurement for 479.3.4 (Foundations) shall be by cubic yard of material removed.



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The method of measurement for removal of traffic items specified in 474.2.5 shall be by lump sum for incidental traffic items removal by intersection.

### **480.4 PAYMENT:**

Removal of existing facilities by type, measured as provided above, will be paid for at the contract price. Said price shall be full compensation for the removal, transportation, and delivery of salvaged items or the removal and the disposal of removed items not scheduled to be salvaged as specified and shown on the project plans.



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### SECTION 900 ILLUMINATED STREET SIGNS

#### **900.1 DESCRIPTION:**

The work under this section shall consist of removing, storing and re-installing existing illuminated street signs and/or furnishing and installing illuminated street signs at each signalized intersection per the approved traffic signal plans. Contractor-supplied illuminated street signs must look and operate the same as the existing signs throughout the City of Phoenix.

#### **900.2 MATERIALS:**

Illuminated street signs supplied by the contractor shall be as specified herein. The illuminated street signs shall be either single faced or double faced as specified in the approved traffic signal plans. The illuminated face shall be 0.177" thick clear polycarbonate, as a substrate, with a green EC film and translucent reflective sheeting. LED products shall be compatible with existing signs.

**900.2.1 Size and Style:** The actual size of the illuminated sign face is provided in the table below. The sign cabinet will be larger than these dimensions and will include the size(s) of the cabinet lip that is used to hold the sign face in place. The style shall be one illuminated face, single-sided sign or two illuminated faces, double-sided sign.

Size
20 inches x 8 feet
20 inches x 9 feet
36 inches x 8 feet

**900.2.2 Sign Design:** The sign design shall include the street name, block number with direction, and City of Phoenix logo. The contractor shall provide the Traffic Signal Engineer or designee with graphic files for the proposed artwork via email. The name of the font to be used is the Clearview One UC-35 & Clearview One BD-55. The contractor's computer sign cutter shall be able to use True Type fonts to run this program.

The sign background shall be green with white letters, City logo, and borders. The contractor shall produce the green background with the green EC film.

**900.2.3 Sign Cabinet Fabrication and Wiring Process:** Sign cabinet shall be of good workmanship, water resistant with weepholes to drain condensation. The sign and sign cabinet must be rectangular in shape with a smooth, clean appearance without the presence of ridges or angles other than right angles. Contractor shall provide the proposed sign design shop drawings including mounting details for approval prior to ordering the signs. The shop drawings, including the cantilever mounting mechanism shall be approved by an Arizona Licensed Structural Engineer.

To prevent reflection from the streetlight above the sign, the sign cabinet must be designed to angle



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slightly down toward the traffic. In addition, the cabinet will also leave a slight overhang to shield the sign face from the streetlight above. The exact angle and size of the overhang shall be approved by the Traffic Signal Engineer or designee.

The sign cabinet shall be painted with enamel paint to the City of Phoenix specified color to match the color of the traffic signal poles being supplied under this contract.

The sign cabinet shall be designed for ease of maintenance. The cabinet shall include top-hinged doors on both sides and have two prop rods for each door to stabilize them when open. The doors must open up, not open down or slide down or sideways.

The sign cabinets must include lighting assemblies internal to the sign. The LED sign shall operate on a 120-volt circuit.

Each sign shall be supplied with an individual photo electric switch to provide for dusk to dawn operation. This switch must be placed in the sign housing in such a manner that it will not be influenced by the luminaries located above the sign.

### **900.3 CONSTRUCTION REQUIREMENTS:**

**900.3.1 Existing Illuminated Street Signs to be Removed & Re-installed:** Contractor shall carefully remove any existing illuminated street signs that will be reinstalled on new traffic signal poles. Contractor shall safely transport and store the removed sign and return it at the time of final installation. Contractor shall provide pictures of all signs prior to removal. All signs damaged while in possession of the contractor shall be replaced at no cost to the City of Phoenix.

Typical illuminated street signs are flag mounted above the mast arm on the 4-inch diameter riser. For these types of installations, mounting hardware should be preserved for re-use. Other mounting configurations will most likely require new mounting hardware.

### **900.3.2 New Illuminated Street Signs:**

Contractor shall install new illuminated street signs in accordance with the manufacturer's installation instructions at the locations specified on the approved traffic signal plans.

### **900.3.3 Illuminated Street Sign Wiring:**

Locate the sign junction box to the traffic signal pole adjacent to the illuminated street sign or as directed by the Traffic Signal Engineer or designee. Attach the sign junction box by drilling and tapping the pole with two 1"x1/4"x20 screws or other appropriate length. Connect the 3-conductor pigtail cable coming from the sign through the seal-tight to the weather-tight connector entering the sign junction box.

Install an IMSA 19-1 Cable, 3-conductor, #16 stranded with a PVC outer jacket continuous without splice from the sign junction box to the junction box located below traffic signal pole



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marked and terminated as shown on the approved traffic signal plans and COP Traffic Signal Standard Details.

### **900.4 MEASUREMENT:**

Illuminated street signs will be measured as a unit for each size of sign, by number of faces of sign furnished and installed.

### **900.5 PAYMENT:**

The accepted quantities of signs measured as provided above will be paid for at the contract unit price by size and number of faces which shall be full compensation for the work, including sign cabinet, sign faces, mounting hardware, LED light sources, photocell, internal wiring, the 3-conductor pigtail with seal-tight and connectors, sign junction box, external cable run from sign junction box through traffic signal pole to the traffic signal junction box, and any other incidentals for complete installation of the signs COMPLETE IN PLACE.



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### SECTION 901 WIRELESS NETWORK RADIO

#### **901.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing a wireless network radio at designated signalized intersections as shown on the equipment sheet of the approved traffic signal plans.

#### **901.2 MATERIALS:**

Provide Tropos model 6420XA with a weatherized gateway plate. Each radio shall come with a Tropos control server license.

##### **901.2.1 Cat 5e Cable:**

1. Conductor Material: BC - Bare Copper
2. Insulation Material: PO - Polyolefin
3. Outer Shield Material: Foil
4. Outer Shield Material: Aluminum Foil-Polyester Tape/TC - Tinned Copper
5. TC Braided Stainless Steel Shield
6. Outer Jacket Material: Industrial Grade PVC - Polyvinyl Chloride Plenum (Y/N): N
7. Outer Jacket Color – Teal
8. Cable Termination – RJ45 connector suitable for outdoor use

##### **901.2.2 Power Connector and Cable:**

1. 3-wire, watertight female Remke PVC mini-link plug compatible with male connector on radio
2. IMSA 19-1, 3 conductor #16 cable

#### **901.3 CONSTRUCTION REQUIREMENTS:**

Install the wireless mesh radio on the vertical portion of the 20' riser. The radio shall be installed so that the antenna extends beyond the top of the riser and as level as possible using the leveling instrument on the radio with the antennas in the vertical position.

A 1/2-inch hole shall be drilled near the radio facing the center of the intersection. A rubber grommet shall be installed in the hole to protect the cable.

Install IMSA 19-1, 3 conductor cable in a single run from the radio through the pole, conduit, and junction boxes to the breaker termination point in the traffic signal cabinet. Install female mini-link plug to 3-conductor power cable in accordance with manufacturer requirements to ensure watertight connection.

Install Cat 5e cable from the radio to the controller cabinet without splice where the Engineer or designee specifies. On the controller cabinet end, leave a 10' coil of spare cable. Terminate each





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end of the cable with an RJ45 connector. Contractor shall provide documentation that the CAT5e cable with terminated RJ45 connectors on both ends has passed a continuity test of all conductors. Plug in RJ45 connector into the radio and the ethernet switch in the cabinet. Cable shall be marked "Wireless Radio" on a Brady tag or approved equivalent.

### **901.4 MEASUREMENT:**

Wireless network radios will be measured as a unit for each size of radio furnished and installed.

### **901.5 PAYMENT:**

The accepted quantities of radios measured as provided above, will be paid for at the contract unit price which shall be full compensation for the work, COMPLETE IN PLACE including mounting hardware, connection of the wireless radio to external cable, external cable from the radio through poles and conduit to the controller cabinet. and any incidentals for complete installation of the radio.



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### SECTION 902 PTZ CCTV

#### **902.1 DESCRIPTION:**

The work under this section shall consist of furnishing and installing a pan-tilt-zoom (PTZ) Closed Circuit TV (CCTV) at locations specified on the equipment sheet of the approved traffic signal plan

#### **902.2 MATERIALS:**

##### **902.2.1 Cat 5e Cable:**

- a) Conductor Material: BC - Bare Copper
- b) Insulation Material: PO - Polyolefin
- c) Outer Shield Material: Foil
- d) Outer Shield Material: Aluminum Foil-Polyester Tape/TC - Tinned Copper
- e) TC Braided Stainless Steel Shield
- f) Outer Jacket Material: Industrial Grade PVC - Polyvinyl Chloride Plenum (Y/N): N
- g) Outer Jacket Color – Teal
- h) Cable Termination – RJ45 connector suitable for outdoor use

##### **902.2.2 Generic IP, POE Plus, POE Outdoor Network Camera SpecCamera – AXIS Q6355-LE PTZ CAMERA or Approved Equivalent**

- a) Lightfinder - Lightfinder 2.0
- b) Min illumination / light sensitivity (Color) - 0.06 lux
- c) Min illumination / light sensitivity (B/W) - 0.001 lux
- d) Image sensor – CMOS
- e) Image sensor size – 1/1.7”
- f) Wide dynamic range – Forensic WDR

##### **Pan, Tilt, Zoom**

- a) Optical zoom – 31
- b) Pan range – 360 endless
- c) Tilt range - +20 to -90
- d) Guard tour – preset position tour
- e) Digital zoom – 12

##### **Security**

- a) Signed OS
- b) Secure Boot

##### **General**

- a) Built-in IR
- b) Optimized IR
- c) Local storage (memory card slot)



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- d) Operating temperature - -50° to 55° C
- e) Outdoor Ready
- f) Vandal rating – IK10
- g) IP rating – IP66, IP67
- h) Designed for repaint

### **Analytics**

- a) Auto tracking version – Autotracking 2
- b) Orientation aid – orientation aid PTZ

### **Video**

- a) Max video resolution – 1920x1080
- b) Max frames per second – 50/60
- c) Day and Night functionality
- d) Electronic image stabilization

### **Lens**

- a) Focal length – 6.91 – 214.64 mm
- b) Horizontal field of view – 60.6 – 2.0
- c) Vertical field of view – 36.5 – 1.1

### **Compression**

- a) Zipstream
- b) H.264 – Baseline, High, Main
- c) H.265
- d) AV1

### **Audio**

- a) Audio Support\* - Yes

### **System Integration**

- a) Active tampering

### **Network**

- a) PoE Class - 6

### **902.2.3 Cable Support Strain relief**

- Single weave variable mesh grip
- Galvanized steel for additional holding power in abrasive environments
- Strand equalizers position wires for equal loading
- Single eye
- Safety springs are available to reduce tension and prevent pullouts
- 0.24" – 1.5" cable diameter range

### **902.3 CONSTRUCTION REQUIREMENTS:**

The PTZ CCTV network camera shall be installed per manufacturer's specifications, using the appropriate camera housing, pole mount shoe, and wall mount bracket and approved banding per City specifications. The CCTV camera shall be installed at the corner where the Engineer or designee specifies that the vertical extension pole be installed for use by the CCTV camera.



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The CCTV camera shall be configured with the IP and network parameters provided by the City of Phoenix ITS Network Manager or designee.

A 1/2-inch hole shall be drilled on extension pole 12 inches from the top facing the center of the intersection. A rubber grommet shall be installed in the hole to protect the cable.

The pole shoe shall be banded around the pole and the Camera shall be installed using the mfg. wall mount facing the center of the intersection.

The Cat 5e cable shall have a cable strain relief installed and attached to a screw on the top of the pole. A hole shall be drilled and tapped into the top of the extension pole so that a 1/4-20 x 1" screw could be used to fasten the cable strain relief. The Cat 5e cable shall be terminated with an RJ45 connector connected to the camera.

A Cat 5e cable shall be run continuously from the camera to the traffic signal cabinet. 10' of the terminated and tested Cat 5e cable shall be coiled and left at the cabinet pedestal. Contractor shall provide documentation that the Cat 5e cable with terminated RJ45 connectors on both ends has passed a continuity test of all conductors. Plug in RJ45 connector into the radio and the ethernet switch in the cabinet. Cable shall be marked "PTZ Camera" on a Brady tag or approved equivalent. Cable shall be paid for separately.

### **902.4 MEASUREMENT:**

PTZ CCTV will be measured as a unit, furnished and installed.

### **902.5 PAYMENT:**

The accepted quantities of PTZ CCTVs measured as provided above will be paid for at the contract unit price which shall be full compensation for the work, COMPLETE IN PLACE including mounting hardware, cable terminations, mounting, testing of the cable and camera, and any incidentals for complete installation of the CCTV.

## Appendix A: Pay Items for Traffic Signal and ITS Devices

Item #	Item Description	Units
	<b>Section 471 - Electrical Underground Installation</b>	
M4711001	Provide 1.5" PVC conduit	L.F.
M4711002	Provide 2" PVC conduit	L.F.
M4711003	Provide 2.5" PVC conduit	L.F.
M4711004	Provide 3" PVC conduit	L.F.
M4711005	Provide 1.5" HDPE conduit	L.F.
M4711006	Provide 2" HDPE conduit	L.F.
M4711007	Provide 2.5" HDPE conduit	L.F.
M4711008	Provide 3" HDPE conduit	L.F.
M4711009	Provide 1" Rigid Metallic conduit	L.F.
M4711010	Provide 2" Rigid Metallic conduit	L.F.
M4711011	Provide 2.5" Rigid Metallic conduit	L.F.
M4711012	Provide 3" Rigid Metallic conduit	L.F.
M4712001	Provide and install # 3.5 Junction Box and sump	Each
M4712002	Provide and install # 5 Junction Box and sump	Each
M4712003	Provide and install # 7 Junction Box and sump	Each
M4712004	Provide and install # 9 Junction Box and sump	Each
M4712005	Install power company (APS) streetlighting junction box and sump per power companies' requirements	Each
M4712006	Supply and install power company (SRP) streetlighting junction box and sump per power companies' requirements	Each
M4713001	Trenching- Less than 45" deep in normal soil conditions under existing pavement	L.F.
M4713002	Trenching- More than 45" deep in normal soil conditions under existing pavement	L.F.
M4713003	Trenching- Less than 45" deep in hard soil conditions under existing pavement	L.F.
M4713004	Trenching- More than 45" deep in hard soil conditions under existing pavement	L.F.
M4713005	Trenching- Less than 45" deep in normal soil conditions under new pavement or landscaping	L.F.
M4713006	Trenching- More than 45" deep in normal soil conditions under new pavement or landscaping	L.F.
M4713007	Trenching- Less than 45" deep in hard soil conditions under new pavement or landscaping	L.F.
M4713008	Trenching- More than 45" deep in hard soil conditions under new pavement or landscaping	L.F.
M4714001	Directional boring in normal soil conditions	L.F.
M4714002	Directional boring in hard soil conditions	L.F.

M4715001	Rigid Metallic conduit attached to structure	L.F.
	<b>Section 472 - Traffic Signal Foundations</b>	
M4720001	Utility potholing in roadway. All potholes shall be filled using half sack slurry up to bottom of road surface and patched with matching pavement material.	Each
M4720002	Utility potholing not in roadway. All potholes shall be tamped to meet compaction requirements.	Each
M4721001	Foundation for Type PB Pole Drilling in Normal Soil Conditions	Each
M4721002	Foundation for Type PB Pole Drilling in Hard Soil Conditions	Each
M4721003	Foundation for Type PB Pole Soft Digging to Avoid Utilities	Each
M4721004	Foundation for Type A Pole Drilling in Normal Soil Conditions	Each
M4721005	Foundation for Type A Pole Drilling in Hard Soil Conditions	Each
M4721006	Foundation for Type A Pole Soft Digging to Avoid Utilities	Each
M4721007	Foundation for Type G/LM Pole Drilling in Normal Soil Conditions	Each
M4721008	Foundation for Type G/LM Pole Drilling in Hard Soil Conditions	Each
M4721009	Foundation for Type G/LM Pole Soft Digging to Avoid Utilities	Each
M4721010	Foundation for Type SM Pole Drilling in Normal Soil Conditions	Each
M4721011	Foundation for Type SM Pole Drilling in Hard Soil Conditions	Each
M4721012	Foundation for Type SM Pole Soft Digging to Avoid Utilities	Each
M4721013	Foundation for Type SR Pole Drilling in Normal Soil Conditions	Each
M4721014	Foundation for Type SR Pole Drilling in Hard Soil Conditions	Each
M4721015	Foundation for Type SR Pole Soft Digging to Avoid Utilities	Each
M4721016	Foundation for Type SQ Pole Drilling in Normal Soil Conditions	Each
M4721017	Foundation for Type SQ Pole Drilling in Hard Soil Conditions	Each
M4721018	Foundation for Type SQ Pole Soft Digging to Avoid Utilities	Each
M4722001	Foundation for Type BP Pole Drilling in Normal Soil Conditions	Each
M4722002	Foundation for Type BP Pole Drilling in Hard Soil Conditions	Each
M4722003	Foundation for Type BP Pole Soft Digging to Avoid Utilities	Each
M4722004	Foundation for Type AP Pole Drilling in Normal Soil Conditions	Each
M4722005	Foundation for Type AP Pole Drilling in Hard Soil Conditions	Each
M4722006	Foundation for Type AP Pole Soft Digging to Avoid Utilities	Each
M4722007	Foundation for Type GP Pole Drilling in Normal Soil Conditions	Each
M4722008	Foundation for Type GP Pole Drilling in Hard Soil Conditions	Each
M4722009	Foundation for Type GP Pole Soft Digging to Avoid Utilities	Each
M4722010	Foundation for Type LP Pole Drilling in Normal Soil Conditions	Each
M4722011	Foundation for Type LP Pole Drilling in Hard Soil Conditions	Each
M4722012	Foundation for Type LP Pole Soft Digging to Avoid Utilities	Each
M4722013	Foundation for Type P45/DP45 Pole Drilling in Normal Soil Condtn	Each
M4722014	Foundation for Type P45/DP45 Pole Drilling in Hard Soil Condtn	Each
M4722015	Foundation for Type P45/DP45 Pole Soft Digging to Avoid Utilities	Each
M4722016	Foundation for Type P70/DP70 Pole Drilling in Normal Soil Condtn	Each
M4722017	Foundation for Type P70/DP70 Pole Drilling in Hard Soil Condtn	Each
M4722018	Foundation for Type P70/DP70 Pole Soft Digging to Avoid Utilities	Each

M4723001	Foundation for ADOT Type J, K, Q & R Pole Drilling in Normal Soil Conditions	Each
M4723002	Foundation for ADOT Type J, K, Q & R Pole Drilling in Hard Soil Conditions	Each
M4723003	Foundation for ADOT Type J, K, Q & R Pole Soft Digging to Avoid Utilities	Each
M4723004	Foundation for ADOT Type V & W Pole Drilling in Normal Soil Conditions	Each
M4723005	Foundation for ADOT Type V & W Pole Drilling in Hard Soil Conditions	Each
M4723006	Foundation for ADOT Type V & W Pole Soft Digging to Avoid Utilities	Each
M4724001	Foundation for Power Pedestal Type 'A'	Each
M4724002	Foundation for Power Pedestal Type 'B'	Each
M4724003	Foundation for Power Company Transformer or Switch Cabinet	Each
M4724004	Foundation for Traffic Signal Controller Cabinet	Each
M4725001	Additional cost for class 'A', 4000 psi concrete	CY
M4725002	Additional cost for class 'A', 5000 psi concrete	CY
	<b>Section 473 - Detectors</b>	
M4731001	6' by 6' Loop Detector	Each
M4731002	5' by 20' Quadrapole Loop Detector	Each
M4731003	5' by 40' Quadrapole Loop Detector	Each
M4731004	5' by 60' Quadrapole Loop Detector	Each
M4731005	5' by 80' Quadrapole Loop Detector	Each
M4731006	5' by 100' Quadrapole Loop Detector	Each
M4731007	Bicycle Loop Detector	Each
M4732001	Pedestrian Push Button (Bullnose)	Each
M4732002	Accessible Pedestrian Signal (APS) Push Button	Each
M4733001	Non-Intrusive Detection System for 1-Legged Intersection	Each
M4733002	Non-Intrusive Detection System for 2-Legged Intersection	Each
M4733003	Non-Intrusive Detection System for 3-Legged Intersection	Each
M4733004	Non-Intrusive Detection System for 4-Legged Intersection	Each
M4733005	Non-Intrusive Detection System for 5-Legged Intersection	Each
	<b>Section 474 – Emergency Vehicle Detection</b>	
M4741001	Tomar Emergency Vehicle Detector Unit	Each
	<b>Section 475 - Traffic Signal Poles and Accessories</b>	
M4751001	Type A Pole – 15'	Each

M4751002	Type A Pole – 20'	Each
M4751003	Type PB Pole – 4'	Each
M4751004	Type LM Pole	Each
M4751005	Type SM Pole	Each
M4751006	Type SR Pole	Each
M4751007	Type SQ Pole	Each
M4751008	15' mast arm for SR/SM Pole	Each
M4751009	20' mast arm for SR/SM Pole	Each
M4751010	25' mast arm for SR/SM Pole	Each
M4751011	30' mast arm for SR/SM Pole	Each
M4751012	35' mast arm for SR/SM Pole	Each
M4751013	40' mast arm for SR Pole	Each
M4751014	45' mast arm for SR Pole	Each
M4751015	50' mast arm for SR Pole	Each
M4751016	55' mast arm for SQ Pole	Each
M4751017	60' mast arm for SQ Pole	Each
M4751020	COP Luminaire mast arm	Each
M4751021	1' Riser with Single Luminaire Mast Arm Shoe	Each
M4751022	1' Riser with Dual Luminaire Mast Arm Shoes at 90° Orientation	Each
M4751023	1' Riser with Dual Luminaire Mast Arm Shoes at 180° Orientation	Each
M4751024	5' Riser with Single Luminaire Mast Arm Shoe	Each
M4751025	5' Riser with Dual Luminaire Mast Arm Shoes at 90° Orientation	Each
M4751026	5' Riser with Dual Luminaire Mast Arm Shoes at 180° Orientation	Each
M4751027	10' Riser with Single Luminaire Mast Arm Shoe	Each
M4751028	10' Riser with Dual Luminaire Mast Arm Shoes at 90° Orientation	Each
M4751029	10' Riser with Dual Luminaire Mast Arm Shoes at 180° Orientation	Each
M4751030	20' Riser with Single Luminaire Mast Arm Shoe	Each
M4751031	20' Riser with Dual Luminaire Mast Arm Shoes at 90° Orientation	Each
M4751032	20' Riser with Dual Luminaire Mast Arm Shoes at 180° Orientation	Each
M4751033	Blank Top Plate (Used when riser is not required)	Each
M4751034	Type AP Pole – 15'	Each
M4751035	Type AP Pole – 20'	Each
M4751036	Type BP Pole – 4'	Each
M4751037	Type GP Pole	Each
M4751038	Type LP Pole	Each
M4751039	Type P45 Pole	Each
M4751040	Type DP45 Pole	Each
M4751041	Type P70 Pole	Each
M4751042	Type DP70 Pole	Each
M4751043	15' Primary Mast Arm for P45 Pole (M15P45)	Each
M4751044	30' Primary Mast Arm for P45 Pole (M30P45)	Each
M4751045	15' Primary Mast Arm for P70 Pole (M15P70)	Each
M4751046	30' Primary Mast Arm for P70 Pole (M30P70)	Each
M4751047	40' Primary Mast Arm for P70 Pole (M40P70)	Each
M4751048	55' Primary Mast Arm for P70 Pole (M55P70)	Each



M4751049	1' Mast Arm Extension for P45/P70 Pole	Each
M4751050	5' Mast Arm Extension for P45/P70 Pole	Each
M4751051	10' Mast Arm Extension for P45/P70 Pole	Each
M4751052	15' Mast Arm Extension for P45/P70 Pole	Each
M4751053	Damper	Each
M4752001	ADOT Type J Pole	Each
M4752002	ADOT Type K Pole	Each
M4752003	ADOT Type R Pole	Each
M4752004	ADOT Type Q Pole	Each
M4752005	ADOT Type V Pole	Each
M4752006	ADOT Type W Pole	Each
M4752007	20' Mast Arm for ADOT J/Q Pole	Each
M4752008	25' Mast Arm for ADOT J/Q Pole	Each
M4752009	30' Mast Arm for ADOT J/Q Pole	Each
M4752010	35' Mast Arm for ADOT J/Q Pole	Each
M4752011	40' Mast Arm for ADOT J/Q Pole	Each
M4752012	45' Mast Arm for ADOT K/R Pole	Each
M4752013	50' Mast Arm for ADOT K/R Pole	Each
M4752014	55' Mast Arm for ADOT K/R Pole	Each
M4752015	60' Mast Arm for ADOT V/W Pole	Each
M4752016	65' Mast Arm for ADOT V/W Pole	Each
M4752017	ADOT 8' Luminaire Mast Arm	Each
M4752018	ADOT 12' Luminaire Mast Arm	Each
	<b>Sect. 476 - Electrical Power Service Pedestal &amp; Controller Cabinet</b>	
M4761001	Type 'A' Electrical Power Service Pedestal	Each
M4761002	Type 'B' Electrical Power Service Pedestal	Each
M4761003	Controller Cabinet	Each
	<b>Section 477 - Traffic Signal Heads and Mountings</b>	
M4771001	Type F Signal Head	Each
M4771002	Type F1 Signal Head	Each
M4771003	Type G Signal Head	Each
M4771004	Type G1 Signal Head	Each
M4771005	Type Q Signal Head	Each
M4771006	Type Q2 Signal Head	Each
M4771007	Type R Signal Head	Each
M4771008	Type R1 Signal Head	Each
M4771009	Pedestrian Signal Head	Each
M4771010	Type T Signal Head	Each
M4771011	Type T1 Signal Head	Each
M4771012	Type FA Signal Head	Each
M4771013	Type FAI Signal Head	Each
M4771014	Type B Signal Head	Each

M4771015	Type B1 Signal Head	Each
	<b>Section 478 - Traffic Signal Intersection Street Lighting</b>	
M4781001	Gray Traffic Signal Luminaire	Each
M4781002	Bronze Traffic Signal Luminaire	Each
	<b>Section 479 - Electrical Conductors</b>	
M4791001	Single Conductor Wire #10 AWG white	L.F.
M4791002	Single Conductor Wire #8 AWG black	L.F.
M4791003	Single Conductor Wire #8 AWG white	L.F.
M4791004	Single Conductor Wire #8 AWG green	L.F.
M4791005	Single Conductor Wire #10 AWG black	L.F.
M4791006	Single Conductor Wire #10 AWG white	L.F.
M4791007	Single Conductor Wire #10 AWG green	L.F.
M4792001	3C IMSA Cable #14 AWG Solid	L.F.
M4792002	5C IMSA Cable #14 AWG Solid	L.F.
M4792003	7C IMSA Cable #14 AWG Solid	L.F.
M4792011	3C IMSA Cable #16 AWG Solid	L.F.
M4792012	5C IMSA Cable #16 AWG Solid	L.F.
M4792013	7C IMSA Cable #16 AWG Solid	L.F.
M4792014	20C IMSA Cable #16 AWG Solid	L.F.
M4792015	25C IMSA Cable #16 AWG Solid	L.F.
M4793001	3C IMSA Cable #14 AWG Stranded	L.F.
M4793002	5C IMSA Cable #14 AWG Stranded	L.F.
M4793003	7C IMSA Cable #14 AWG Stranded	L.F.
M4793011	3C IMSA Cable #16 AWG Stranded	L.F.
M4793012	5C IMSA Cable #16 AWG Stranded	L.F.
M4793013	7C IMSA Cable #16 AWG Stranded	L.F.
M4793014	20C IMSA Cable #16 AWG Stranded	L.F.
M4793015	25C IMSA Cable #16 AWG Stranded	L.F.
M4793016	42C IMSA Cable #16 AWG Stranded	L.F.
M4794001	Shielded Loop Detector Cable	L.F.
M4795001	EVP Detector Cable	L.F.
M4795002	EVP Confirmation Light Cable	L.F.
M4796001	Cat 5e	L.F.
M4799001	Splicing per intersection	L.S.

	<b>Section 480 - Removal &amp; Salvage of Existing Traffic Facilities</b>	
M4801001	Removal of A Pole	Each
M4801002	Removal of PB Pole	Each
M4801003	Removal of LM Pole w/ 5' Riser or Top Blank Plate	Each
M4801004	Removal of LM Pole w/ 10' or 20' Riser	Each
M4801005	Removal of M Pole w/Mast Arm	Each
M4801006	Removal of M Pole w/ Mast Arm and Extension	Each
M4801007	Removal of SM Pole w/ Mast Arm	Each
M4801008	Removal of SM Pole w/ Mast Arm and Extension	Each
M4801009	Removal of SR/SQ Pole w/ Mast Arm	Each
M4801010	Removal of SR/SQ Pole w/ Mast Arm and Extension	Each
M4801011	Removal of C or D Pole	Each
M4801012	Removal of C or D Pole w/ Mast Arm	Each
M4801013	Removal of Type AP Pole	Each
M4801014	Removal of Type BP Pole	Each
M4801015	Removal of Type GP Pole	Each
M4801016	Removal of Type LP Pole	Each
M4801017	Removal of Type P45 Pole w/ Mast Arm and Extension	Each
M4801018	Removal of Type DP45 Pole w/ Mast Arm and Extension	Each
M4801019	Removal of Type P70 Pole w/ Mast Arm and Extension	Each
M4801020	Removal of Type DP70 Pole w/ Mast Arm and Extension	Each
M4802001	Removal of Controller Cabinet	Each
M4802002	Removal of Power Pedestal	Each
M4802003	Removal of Concrete	C.Y.
M4802004	Removal of Asphalt	C.Y.
M4803001	Removal of Foundations/Pedestals	C.Y.
M4804001	Removal of Incidental Traffic Items per Intersection	L.S.
	<b>Sections 481-489 will be used for ITS Devices</b>	
	<b>900 Series - Project Specific Special Items</b>	
	<b>Section 900 – Illuminated Street Sign</b>	
M9001001	20" x 8' Single-sided Illuminated Street Sign	Each
M9001002	20" x 8' Double-sided Illuminated Street Sign	Each
M9002001	20" x 9' Single-sided Illuminated Street Sign	Each
M9002002	20" x 9' Double-sided Illuminated Street Sign	Each
M9003001	36" x 8' Single-sided Illuminated Street Sign	Each
M9003002	36" x 8' Double-sided Illuminated Street Sign	Each
M9003003	Sign Brackets - Pair	Each
	<b>Section 901 – Wireless Network Radio</b>	
M9011001	Wireless Network Radio	Each
M9021001	PTZ CCTV	Each