



# CITY OF HAGERSTOWN, MARYLAND

Department of Parks and Engineering

## TRAFFIC SIGNAL GENERAL REQUIREMENTS

*(Last Revised 3/18/2021)*

For all traffic signal construction in the City of Hagerstown, the following requirements shall be considered as standard equipment and materials:

A. Traffic Signal Poles, Mast Arms and Foundations:

The City of Hagerstown uses a standard 36 foot traffic signal mast arm with a standard pole as shown in Plate TS-010 and TS-011. To establish a standard of quality, traffic signal poles described herein are based on *Union Metal Industries Corporation's* (UMIC) pole structure. It is the intention of the City to establish a grade of quality of material and not to rule out other brands or makes of equal quality. However, if a product other than that specified is quoted, it is the bidder's responsibility to name such product with his quote and to prove to the City that said product is equal to the UMIC product specified. The City shall be the sole judge as to whether a product being offered by the bidder is actually equivalent to the one being specified. The foundation shall be MD 801.01 dated 5-17-07.

When a mast arm longer than 36 feet is required, or if the loadings exceed the assumptions shown on TS-10, then the City standard pole can NOT be used and the appropriate Maryland State Highway Administration mast arm, mast arm pole, foundation and anchor bolts shall be used.

All traffic signal poles, pedestal poles and luminaire brackets shall be painted "Hagerstown Green" (Federal Standard Color Number 595b-14066).

The use of mast arms is the City standard installation. Span wire signal supports shall be the exception based on unusual site conditions.

B. Pedestrian Signal Heads

The City of Hagerstown uses 16-inch countdown pedestrian signals at all signalized pedestrian crossings.

C. Video Detection

The City of Hagerstown uses the latest Econolite brand video detection equipment (currently "Vision")

D. Uninterruptible Power Supplies for Traffic Signals

Uninterruptible power supply systems for traffic signals shall be included at all intersections.

E. Traffic Signal Disconnect and Meter

The traffic signal disconnect and meter housings and materials shall be constructed of stainless steel. The traffic signal disconnect and meter should be mounted on a separate pedestal outside of the strike zone of the traffic signal cabinet.

F. Traffic Signal Heads and Signing

The City of Hagerstown uses all black traffic signal heads with LED modules. PELCO mounting hardware are to be

used for installing traffic signal heads and signs on mast arms.

G. Traffic Signal Cables

All traffic signal cable must meet the requirements of the International Municipal Signal Association (IMSA). One signal head per phase must be wired directly to the cabinet with no splices.

H. Utility Pole Risers

All utility pole risers for power supply must be a minimum of 10 feet in length galvanized steel conduit and mounted on the non-traffic side of the utility pole.

I. Opticom

The installation of an emergency vehicle pre-emption system shall be approved by the City Engineer.

J. Traffic Signal Cabinets

NEMA size "S" cabinets are to be used when installing a ground mount traffic signal cabinet. The cabinet should be installed out of the strike zone of an approaching vehicle.

L. Conduit and Hand Boxes

The City requires at least one traffic signal hand box on each corner with a traffic signal/pedestal pole. The City requires the use of Schedule 80 PVC conduits. Unless otherwise directed by the City or required for capacity, the City hand box (Plate TS-020) shall be used for all hand box applications except for access to the signal controller which shall be the SHA Standard No. MD-811.01, MD-811.02 and MD-811.03.

M. Traffic Signal Controllers

All traffic signal controllers shall meet the general requirements of NEMA TS-2. The City standard traffic signal controller is the latest Econolite controller (currently "Cobalt" series). The City standard conflict monitor is the MMU 16.

NOTE: For any equipment not listed, please follow standard SHA guidelines and standards.

For more information, please see the attached specifications:

1. Traffic Signal Mast Arm Poles
2. Traffic Signal Strain Poles
3. MD 801.01 Signal Structure Foundation (for City Standard poles only) dated 5-17-07
4. Cabinets and Equipment
5. Backup UPS System (Uninterruptible Power Supplies)
6. High Definition IP Based Video Detection Cameras
7. Traffic Signal Heads
8. LED Traffic Signal Modules
9. LED Countdown Pedestrian Signals
10. Audible/Tactile Push Buttons and Signs
11. Galvanized Traffic Signal Pedestrian Poles and Transformer Bases
12. Coating New Galvanized Structures
13. Painting Weathered Galvanized Structures
14. Re-Painting Previously Painted Galvanized Structures
15. Non-Invasive Magneto-inductive Microloop Detector

## SPECIFICATION FOR TRAFFIC SIGNAL MAST ARM POLES

### A. PURPOSE

The purpose of these specifications is to describe the minimum requirements for the design, manufacture, fabrication and delivery of round steel poles for mast arm mounting of traffic signals and signs. By submitting a bid, manufacturers, distributors or vendors agree to design, manufacture, fabricate, finish and deliver the steel mast arm poles at the designated location.

### B. DESIGN REQUIREMENTS

#### 1. GENERAL

- a. Each mast arm pole shall be in accordance with the following specifications and the design specification.
- b. Traffic Signal Mast Arm Poles shall consist of the following:
  - 1) A round tapered steel shaft of the specified length and a diameter at the base as required by the design complete with anchor base, handhole, cast pole cap, flange plate for signal mast arm, anchor bolts, nuts, bolt covers, and all hardware for installation.
  - 2) A tapered steel arm of the specified length and size as required by the design, complete with mounting flange, rubber grommets (3 per arm), removable end cap and all hardware for installation.
- c. All castings shall be clean and smooth, with all details well defined and true to pattern.
- d. Finish: All materials, except the anchor bolts, shall be hot dip galvanized in accordance with ASTM A-123. Materials shall be given a finish color of Hagerstown Green Federal Standard Number 595b-14066. After galvanizing, structures shall be protected from exposure to contaminants such as oil, salts, etc. during storage and/or transportation. The structures shall be brush blasted in accordance with SSPC-SP7 no earlier than twelve (12) hours prior to application of the first coat. Additional surface preparation and coating application shall be in accordance with the manufacturer's recommendations. The finish coating shall be non-porous

when checked with a holiday detector approved by the Engineer. Materials shall conform to any one of the following paint systems or as approved by the Engineer.

1) Paint System

- (a) Spot Primer. Paint meeting the requirements of a zinc rich primer shall have a dry film thickness of 3 to 5 mils.
- (b) Prime Coat. Paint meeting the requirements of a two component polyamide epoxy shall have a dry film thickness of 4 to 6 mils.
- (c) Finish Coat. Paint meeting the requirements of a two component aliphatic polyurethane shall have a dry film thickness of 2 to 4 mils.

2) Materials shall conform to any one of the following paint systems:

- (a) Sherwin Williams, Zinc Clad B 69AHS Spot Primer, Tile Clad II Epoxy B62 Series/B60V70 Prime Coat, and HS Polyurethane B65 Series/B60V30 Finish Coat.
  - (b) Ameron, Amercoat 68 HS Spot Primer, Amercoat 385 Prime Coat, and Amercoat 450 HS Finish Coat.
  - (c) Davis Frost, P-281 Spot Primer, E-375 Prime Coat, Shinethane HS Finish Coat.
  - (d) Courtaulds Coatings, Interzinc 308 Spot Primer, Interseal 670 Prime Coat, and Interthane 990 Finish Coat.
  - (e) Carboline, Carboline 858 Spot Primer, Carboline Penetrating Sealer Prime Coat, and Carboline 133 HB Finish Coat.
  - (f) DuPont, Corlar Epoxy Zinc Spot Primer, Dual Build Epoxy Prime Coat, and Imoron Polyurethane Finish Coat.
- e. All components of the mast arm assemblies shall be designed to resist, at yield strength of the material without destruction, at test loads equivalent to the calculated loads developed by velocity pressure of at least 80 MPH wind in accordance with the 2001 AASHTO.

f. Shafts and signal mast arms shall be made only one length of the best grade, hot-rolled, basic open-hearth steel of not less than #7 Manufacturers Standard Gauge. Only one longitudinal weld and no transverse welds shall be permitted in the fabrication of shafts and signal mast arms. After being formed and welded, the shaft or signal mast arm shall then be longitudinally cold-rolled under sufficient pressure to flatten the weld, forming a round tapered tube, and increase it's physical characteristics so that the metal will have a guaranteed minimum yield strength of 55,000 psi (ATSM A595 GR A or A607-55).

- 1) Shaft: The shaft shall be round in cross section with a uniform taper in diameter from base to top of .14" per foot. Eight sided or poles "bumped" round are not acceptable. For purposes of this requirement the shaft shall be no less than 0.313 x 13.00 x 9.22 x 27'-0". Close manufacturing tolerance shall be held at the top for future telescopic extension for lighting.
- 2) A reinforced handhole frame, complete with cover, shall be welded into the shaft above the base proportionately to the butt diameter. The frame shall be drilled and tapped for a 1/2"-13NC bolt for grounding.
- 3) A flange plate for the signal mast arm shall be welded to the shaft at a height of 18'-0" above the base and supported with side plates tangent to the shaft and gusset plates both top and bottom. The flange plate shall have a deburred 2-1/2" diameter wiring hole and four (4) tapped holes with high-tensile bolts for mounting the signal mast arm.
- 4) The shaft shall have a deburred 4" diameter hole for wiring, directly behind the hole in the mast arm flange plate that matches the hole in the mast arm.
- 5) A "J" hook for wire support shall be welded inside near the top of the shaft.
- 6) The top of the shaft shall have a cast pole cap secured in place with set screws.

g. Anchor Base

- 1) A one piece square steel anchor base conforming to ASTM A709 Gr. 36, and of sufficient strength, size and shape shall be secured to the butt end of the shaft by two continuous electric arc welds. The base shall telescope the shaft, one weld shall be on the inside at the bottom of the shaft while the other weld shall be on the outside at the top of the base. The design shall be such that the welded connection shall develop the full strength of the adjacent shaft section to resist bending action.
- 2) The square base shall be of the size required shall be provided with four holes to receive the anchor bolts. The diameter of the anchor bolt holes and the anchor bolt circle shall be determined by the size of the shaft.
- 3) Four (4) removable cast aluminum covers for the anchor bolts shall be provided with each base. Each cover shall attach to the upright portion of the body of the base by means of a hex head screw.

#### h. Anchor Bolts

- 1) Each anchor bolt shall exhibit 55,000 psi minimum yield strength with an ell bend at the bottom conforming to AASHTO M314 Gr. 55 S1.
- 2) The anchor bolts shall have sufficient thread to allow for two nuts and maximum rake and shall be complete with two nuts, a heavy hex nut on top and a heavy hex nut on bottom and conforming to ASTM A-194 Gr. 2 or 2H.
- 3) The threaded end to approximately 6" below them and the nuts and washers shall be hot-dipped galvanized.
- 4) The diameter and the length of the anchor bolts shall be determined by the size of the shaft. For purposes of this requirement the bolts shall not be less than 1-3/4" x 66" with no hook.
- 5) Four (4) anchor bolts complete with nuts and washers shall be supplied with each shaft.

i. Signal Mast Arm

- 1) The signal mast arm shall be round in cross section with a uniform taper in diameter of .14" per foot from the flange plate to the free end. For purposes of this requirement the mast arm shall not be less 0.250" x 5.96 x 36'-0" long.
- 2) A flange plate of the thickness required shall telescope the large end of the arm and be welded by two continuous electric arc welds. One shall be on the outside of the plate adjacent to the arm and the other weld shall be on the inside of the plate at the end of the tubular cross section. The flange plate shall have four holes for the high-tensile bolts which shall match the four tapped holes in the mounting plate of the shaft.
- 3) A steel removable cap shall be attached to the end of the arm by a screw.
- 4) For each required signal a 1-3/8" diameter hole will be drilled by the contractor in field. A minimum of four (4) rubber grommets with 1" inside diameter suitable for a 1-3/8" hole shall be supplied with the mast arm for installation in the field.
- 5) The arm and mounting plates shall be designed to provide a 1/2" rise in elevation per foot of arm length when installed.
- 6) The traffic signal mast arm shall be positioned as shown on the design specification drawing.

C. CONSTRUCTION

Install the signal structure on a concrete foundation conforming to Section 801.

Breakway base support systems, when specified, shall conform to Section 821.

Repair any finish on the signal structures and mounting hardware damaged during transportation and installation to match the original finish as approved by the Engineer at no additional cost to the City.

D. WARRANTY

The manufacturer, distributor and vendor shall warrant the shaft(s) complete with base plate and flange plate, signal mast arm(s) complete with flange plate, and all associated hardware to be free from defects in material and workmanship for a period of two (2) years from date of delivery. Any defects within this period shall be repaired or replaced by the manufacturer, distributor or vendor, at total cost to the manufacturer, distributor or vendor, including labor, parts, transportation and installation.

E. MANUFACTURER CERTIFICATION

The manufacturer shall submit notarized certification that each and every piece, shaft with anchor base, handhole(s) and flange plate(s), signal mast arm and flange plate, and anchor bolts and all associated hardware were manufactured in accordance with these specifications and the design specification drawing as submitted by the bidder.

F. INSTRUCTION TO BIDDERS

1. Bids shall be accepted for only round tapered shaft(s) and signal mast arm(s) in accordance with the specifications. Bids submitted on any other design shaft(s) or signal mast arm(s) will result in the bid being considered non-responsive and void.
2. All bids shall be submitted on the Bid Form(s) supplied and be complete with Design Specification Drawing(s) with all information complete and certified.
3. Failure to submit any or all of the above requested material will result in the bid being considered non-responsive and void.

*Revised 6/1/2011*  
*Confirmed 1/22/2021*

## SPECIFICATION FOR TRAFFIC SIGNAL STRAIN POLES

### A. PURPOSE

The purpose of these specifications is to describe the minimum requirements for the design, manufacture, and delivery of round steel strain poles for the mounting of traffic signals and signs. By submitting a bid, manufacturers, distributors or vendors agree to design, fabricate, finish and deliver the steel strain poles at designated locations in accordance with the following specification.

### B. DESIGN REQUIREMENTS

All components shall be designed to resist at yield strength of the material without destruction, at test loads equivalent to the calculated loads developed by velocity pressure of at least 80 MPH wind speed in accordance with the 1994 AASHTO specifications.

#### Pole Shaft

The pole shaft shall be a uniformly round tapered tube made from only one length of the best grade, hot-rolled, basic open-hearth steel of not less than #0 Manufacturers Standard Gauge. Only one longitudinal weld and no transverse welds shall be permitted in the fabrication of shafts. After being formed and welded the shaft shall then be longitudinally cold rolled under sufficient pressure to flatten the weld, forming a round tapered tube, and increase it's physical characteristics so the metal will have a guaranteed minimum yield strength of 55,000 psi (ASTM A595, GR A or A607-55). For purposes of this requirement the pole shaft shall be .3175" x 11.0" x 26'-0".

A 4" x 8" handhole reinforcing frame complete with cover shall be welded into the shaft section above the base and stiffening ring. The reinforcing for the handhole shall develop the minimum guaranteed yield strength of the shaft. The reinforcing handhole shall be tapped to accommodate a grounding lug and shall contain a keeper chain attached to the handhole cover. The cover shall be secured to the frame by at least two stainless steel screws.

The shaft shall have a nominal height of 26 feet. A removable pole top cap shall be provided for each shaft. The shaft length and diameter shall be of sufficient size and strength to support the stated signal loads.

A "J" hook for the wire support shall be welded inside near the top of the shaft.

A 3" threaded blind half coupling shall be welded to the shaft @ 180 degrees to the handhole, 30" down from the top of the pole.

### Anchor Base

An anchor base fabricated from steel plate conforming to ASTM A709 Gr. 36 of sufficient strength, size and shape shall be welded to the butt end by two continuous arc welds. The base shall telescope the shaft, one weld on the inside at the bottom of the shaft while the other weld shall be on the outside at the top of the base. The design shall be such that the welded connection shall develop the full strength of the adjacent shaft section to resist bending action.

The base shall be designed to secure the shaft to a concrete foundation by means of a minimum of four (4) standard anchor bolts. Anchor bolts, nuts, washers and removable aluminum covers for the anchor bolts shall be supplied with each pole assembly. The diameter of the anchor bolt holes and the anchor bolts circle shall be determined by the size of the shaft.

Anchor bolts shall exhibit 55,000 psi minimum yield strength with an ell bend at the bottom conforming to AASHTO M314 Gr. 55 S1, 55,000 psi. The anchor bolts shall have sufficient thread to allow for two (2) nuts and maximum rake and shall be complete with two (2) nuts, a heavy hex nut on top and a heavy hex nut on bottom and conforming to ASTM A-194 Gr. 2 or 2H. For purposes of this requirement the anchor bolts shall be 1-3/4" x 90". The threaded end to approximately 6" below them and the nuts shall be hot-dipped galvanized.

The diameter and the length of the anchor bolts shall be determined by the size of the shaft, but shall not be less than 1-3/4" x 90".

### Finish

All materials, except the anchor bolts, shall be hot dip galvanized in accordance with ASTM A-123. Materials shall be given a finish color of Hagerstown Green Federal Standard Number 595b-14066. After galvanizing, structures shall be protected from exposure to contaminants such as oil, salts, etc. during storage and/or transportation. The structures shall be brush blasted in accordance with SSPC-SP7 no earlier than twelve (12) hours prior to application of the first coat. Additional surface preparation and coating application shall be in accordance with the manufacturer's recommendations. The finish coating shall be non-porous when checked with a holiday

detector approved by the Engineer. Materials shall conform to any one of the following paint systems or as approved by the Engineer.

#### Paint System

- (A) Spot Primer. Paint meeting the requirements of a zinc rich primer shall have a dry film thickness of 3 to 5 mils.
- (B) Prime Coat. Paint meeting the requirements of a two component polyamide epoxy shall have a dry film thickness of 4 to 6 mils.
- (C) Finish Coat. Paint meeting the requirements of a two component aliphatic polyurethane shall have a dry film thickness of 2 to 4 mils.

Materials shall conform to any one of the following paint systems:

1. Sherwin Williams, Zinc Clad B 69AHS Spot Primer, Tile Clad II Epoxy B62 Series/B60V70 Prime Coat, and HS Polyurethane B65 Series/B60V30 Finish Coat.
2. Ameron, Amercoat 68 HS Spot Primer, Amercoat 385 Prime Coat, and Amercoat 450 HS Finish Coat.
3. Davis Frost, P-281 Spot Primer, E-375 Prime Coat, Shinethane HS Finish Coat.
4. Courtaulds Coatings, Interzinc 308 Spot Primer, Interseal 670 Prime Coat, and Interthane 990 Finish Coat.
5. Carboline, Carboline 858 Spot Primer, Carboline Penetrating Sealer Prime Coat, and Carboline 133 HB Finish Coat.
6. DuPont, Corlar Epoxy Zinc Spot Primer, Dual Build Epoxy Prime Coat, and Imoron Polyurethane Finish Coat.

#### C. WARRANTY

The manufacturer, distributor and vendor shall warrant the shaft(s) complete with base plate and all associated hardware to be free from defects in material and workmanship for a period of two (2) years from date of delivery. Any defects within this period shall be repaired or replaced by the manufacturer, distributor or vendor, at total cost to the

manufacturer, distributor or vendor, including labor, parts, transportation and installation.

#### D. MANUFACTURER CERTIFICATION

The manufacturer shall submit notarized certification that each and every piece, shaft with anchor base, handhole, and anchor bolts and all associated hardware were manufactured in accordance with these specifications and the design specification drawing as submitted by the bidder.

#### E. CONSTRUCTION

Install the signal structure on a concrete foundation conforming to Section 801.

Breakway base support systems, when specified, shall conform to Section 821.

Repair any finish on the signal structures and mounting hardware damaged during transportation and installation to match the original finish as approved by the Engineer at no additional cost to the City.

#### F. INSTRUCTIONS TO BIDDERS

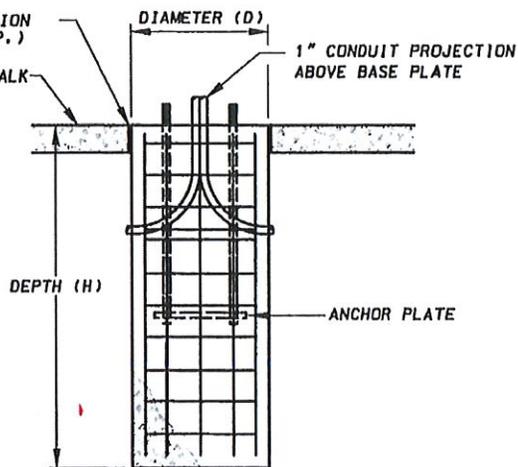
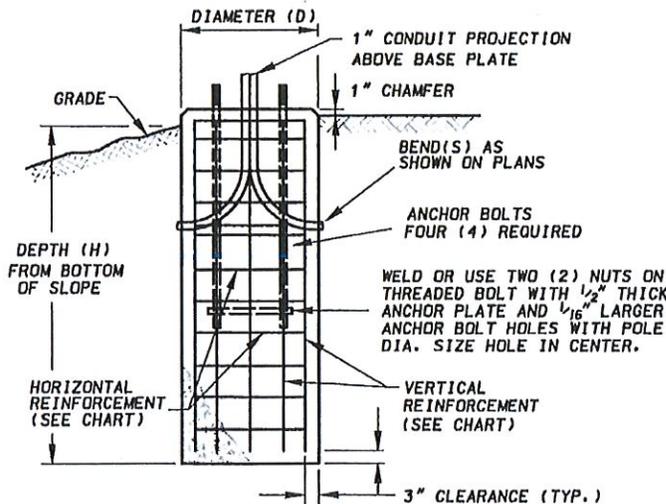
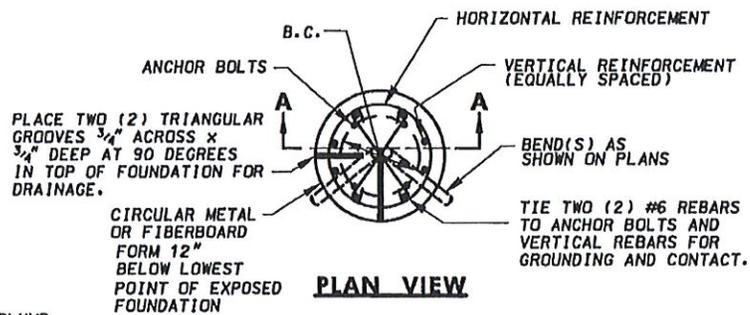
1. Bids shall be accepted for only round tapered shaft(s) in accordance with the specifications. Bids submitted on any other design shaft(s) will result in the bid being considered non-responsive and void.
2. All bids shall be submitted on the Bid Form(s) supplied and be complete with Design Specification Drawing(s) with all information complete and certified.
3. Failure to submit any or all of the above requested material will result in the bid being considered non-responsive and void.

Revised 6/1/2011

POLE TYPE	ARM LENGTH OR POLE SIZE	BOLT CIRCLE (IN.)	ANCHOR BOLT SIZE (IN. x IN.)	ANCHOR BOLT MAX. PROJECTION ABOVE FOUNDATION (IN.)	FOUNDATION REINFORCEMENT				CONCRETE REQUIRED (C.Y.)
					DIAMETER 'D' (FT.)	HEIGHT 'H' (FT.)	VERTICAL REINF.	HORIZONTAL REINF.	
PEDESTAL FOR PUSHBUTTON AND PED. SIGNAL *	5' - 10'	8	SEE NOTE 7	FEMALE ANCHOR FOR COUPLING (SEE NOTE 7)	1 1/2	3	6 NO. 6	NO. 3 @ 12" C.C.	0.2
PEDESTAL	10' / 14' / 20'	11	1 x 36	3 1/4	2	6	6 NO. 8	NO. 3 @ 12" C.C.	0.7
STRAIN	12" DIA. x 30'	16	1 3/4 x 66	7 1/2	3	10	8 NO. 10	NO. 4 @ 12" C.C.	2.7
	12" DIA. x 32'	22	2 1/4 x 72	8 1/2	4	10	16 NO. 10	NO. 4 @ 12" C.C.	4.7
	14" DIA. x 32'	22	2 1/4 x 72	8 1/2	4	10	16 NO. 10	NO. 4 @ 12" C.C.	4.7
MAST ARM	<del>30' SINGLE</del>	<del>16</del>	<del>1 1/2 x 54</del>	<del>6 1/2</del>	<del>3</del>	<del>10</del>	<del>8 NO. 10</del>	<del>NO. 4 @ 12" C.C.</del>	<del>2.7</del>
	50' SINGLE AND TWIN	18	1 3/4 x 66	7 1/2	3	10	8 NO. 10	NO. 4 @ 12" C.C.	2.7
	<del>60' &amp; 70' SINGLE</del>	<del>22</del>	<del>2 x 72</del>	<del>8</del>	<del>4</del>	<del>10</del>	<del>16 NO. 10</del>	<del>NO. 4 @ 12" C.C.</del>	<del>4.7</del>
	<del>50' / 60' - 70' TWIN</del>	<del>22</del>	<del>2 x 72</del>	<del>8</del>	<del>4</del>	<del>10</del>	<del>16 NO. 10</del>	<del>NO. 4 @ 12" C.C.</del>	<del>4.7</del>

**NOTES:**

- MAST ARM POLE FOUNDATIONS SHALL PROJECT ABOVE GRADE TO PROVIDE MAST ARM TO ROADWAY CLEARANCE OF 18' - 20' FULLY LOADED.
- ALL EXPOSED FOUNDATION FACES SHALL BE FINISHED SMOOTH.
- GROUT SHALL NOT BE INSTALLED BETWEEN THE BASE PLATE AND THE TOP OF THE FOUNDATION.
- REFER TO STRAIN POLE, MAST ARM POLE, AND PEDESTAL POLE STANDARD PLATES FOR BOLT CIRCLE AND ANCHOR BOLT DETAILS.
- 1/4" THICK STEEL TEMPLATE PLATE WITH 1/16" LARGER ANCHOR BOLT HOLE SHALL BE USED FOR INSTALLATION.
- ANCHOR BOLTS OR FEMALE ANCHORS SHALL BE PLUMB.
- PEDESTAL FOR PUSHBUTTON AND PEDESTRIAN SIGNAL SHALL USE BREAKAWAY COUPLINGS AND FEMALE ANCHORS.
- \* 8. SHALLOW 1 1/2' x 3' PEDESTAL FOUNDATION SHALL ONLY BE USED WHERE SITE CONSTRAINTS PREVENT USE OF STANDARD 2' x 6' PEDESTAL FOUNDATION.



**SECTION A-A  
NON-SIDEWALK AREA**

**SECTION A-A  
SIDEWALK AREA**

SPECIFICATION <b>801</b>	CATEGORY CODE ITEMS
APPROVED	<i>[Signature]</i> DIRECTOR - OFFICE OF TRAFFIC AND SAFETY
	APPROVAL • SHA REVISIONS
	APPROVAL • FEDERAL HIGHWAY ADMINISTRATION
	APPROVAL 7-1-94
	REVISD 5-17-07
	REVISD 5-2-07

**Maryland Department of Transportation  
STATE HIGHWAY ADMINISTRATION**  
STANDARDS FOR HIGHWAYS AND INCIDENTAL STRUCTURES

**SIGNAL STRUCTURE FOUNDATIONS**

**STANDARD NO.**

**MD 801.01**

**SPECIFICATION FOR  
TRAFFIC CONTROL DEVICES  
CABINETS AND EQUIPMENT**

**DESCRIPTION.** Furnish and install traffic signal controllers and cabinets, furnish and install Intelligent Transportations Systems control cabinets, and furnish and install lighting control cabinets for highway and sign lighting.

**MATERIALS.** Conduit 902.10, 921.07.01, 921.07.03, and 950.11 Control and Distribution Equipment 950.13 Anchor Bolts, Hardware, Cabinets and Controllers as approved by the City of Hagerstown. All materials, equipment and installations shall be new, UL listed or labeled, and meet NEC, NESC, NEMA, IES, and local codes and ordinances applicable to the installation.

**CONSTRUCTION.**

**Base Mounted Traffic Signal Cabinets.** Mount cabinets on concrete foundations conforming to Section 801. Furnish and install conduit as specified in Section 805.

**Pole Mounted Traffic Signal Cabinets.** Install cabinets as specified. Furnish and install conduit as specified in Section 805.

**Base Mounted Lighting Cabinets.** Furnish and install the equipment enclosure, panel boards, transformers, circuit breakers, lighting contactor, relay, photoelectric controls, thermostats, selector switches, fans, lightning arresters, conduit, wiring and wiring devices, and all other equipment necessary to provide a complete functioning lighting cabinet as specified. Protect all electrical outlets with ground fault circuit interrupters (GFCI).

**Pole Mounted Lighting Cabinets.** Furnish and install a NEMA 4X, stainless enclosure with hardware for attaching the unit to a utility pole, wood post, or traffic control device structure. Include a 60 amp, double pole main circuit breaker; a 60 amp, double pole electrically held lighting contactor; four double pole circuit breakers at the amperage specified in the Contract Documents; photoelectric control; lightning arrester; and all incidentals necessary to provide a complete lighting control unit.

**MEASUREMENT AND PAYMENT.**

**Furnishing and installing** signal controllers and cabinets will be measured and paid for at the Contract unit price per each for the pertinent Install Traffic Signal Controllers and Cabinets item. The payment will be full compensation for furnishing, and installation of the controller or cabinet when applicable, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Concrete foundations for Traffic Control Devices and Equipment will not be measured and paid for but will be incidental to the pertinent traffic control cabinet.

Conduit will not be measured and paid for but will be incidental to the pertinent traffic control cabinet.

Ground rods will be measured and paid for but will be incidental to the pertinent traffic control cabinet.

**SPECIFICATION FOR**  
**BACKUP UPS SYSTEM FOR TRAFFIC SIGNALS**

**DESCRIPTION**

This work shall consist of furnishing and installing a dual conversion, rack-mounted, microprocessor-controlled battery-backup Uninterruptible Power Supply (UPS) system, complete with cabinet and batteries, for traffic signals as shown in the Contract Documents or as directed by the Engineer.

**MATERIALS**

UL 1778, CUL Pending  
FCC Class A  
IEEE 587/ANSI C62.41  
IEC 555 @ 120 VAC

**CONSTRUCTION****UPS SYSTEM**

The UPS system shall be 100% Digital, true sine wave, on-line, solid state, microprocessor controlled power conditioner and controlled high-frequency inverter and Battery Backup System (BBS), utilizing insulated-gate bipolar transistor (IGBT) technology. The system shall continuously regenerate and condition the AC output sine wave to insure that 100 percent of the power supplies all connected loads, whether the system is operating on the public utility or on batteries. The minimum operating time for batteries is 2.5 to 3 hours. The on-board inverter shall digitally generate all power.

- (a) The UPS system shall be capable of operating at its rated power level with all existing equipment on the system, regardless of the composition of the load (incandescent and/or LED signal heads, signal controllers, load switches, and conflict monitors).
- (b) The UPS shall be capable of producing, simultaneously, all digital fully regenerated, conditioned and true sine wave, and continuous AC outputs. The UPS system shall be fully compatible with all traffic signal control equipment, including:
  - (1) Conflict Monitors and Load Switches
  - (2) LED Signals, including Countdown and Audible Pedestrian Signals
  - (3) Incandescent Signals

- (c) The normal operating mode for all signal elements shall be continuous regenerated power. Continuous output shall be provided for all controllers and all other cabinet equipment including modems, conflict monitors, communications, and monitoring equipment, in addition to all signal system elements.
- (d) The UPS system shall be capable of running any combination of signal heads, up to its maximum rating, whether Incandescent, LED or Neon, by any manufacturer, regardless of power factor, without overdriving the lowest power factor LED heads (which may cause early degradation, low luminosity, or early signal failure).
- (e) The UPS system shall utilize the existing Flasher Modules and Flash Transfer relays.
- (f) The UPS system shall be compatible with police panel functions (i.e. "Signals Off" switch must kill power to the field wiring even when on UPS/Battery Power).
- (g) The UPS system shall not duplicate or take over flash operation or flash transfer relay functions.
- (h) The UPS system shall be capable of providing continuous, fully 100 percent real-time, fully conditioned, regulated, sinusoidal (AC) power to selected devices such as signal controllers, modems, communication hubs, NTCIP adapters and video equipment.
- (i) The UPS system shall support load increases to 1,400 watts for ten seconds through the full NEMA temperature range of -40 degrees C to +74 degrees C on continuous battery operation.

### **POWER MODULE**

Upon loss of power from the public utility, the UPS system shall utilize its battery power through the Power Interface Module (PIM).

- (a) In the event the UPS system fails or the battery becomes depleted, the PIM shall disconnect the UPS system and, upon return of utility power, the traffic control system shall default to normal operating mode.
- (b) The Power Interface Module shall enable the removal and replacement of the UPS system without shutting down the traffic control system (i.e. "hot swap" capability). The connectors shall be equipped with a "safety interlock" feature.

**BATTERY SYSTEM**

- (a) The battery charging system shall be a 3-stage system designed for extended life of the battery system by temperature compensated as well pulse charging in addition to automatically regulated current levels.
- (b) Battery charging shall be as required regardless whether the UPS is running on utility power or an auxiliary power source.
  - (1) The UPS shall continue to supply clean regulated power even if the batteries are depleted and the system is on utility or auxiliary power
  - (2) The UPS shall not go to bypass during its charging cycles.
- (c) The battery system shall be certified and field proven to meet or exceed NEMA temperature standards from -40 degrees C to +74 degrees C.
- (d) The battery system shall have a 51 Ampere-Hour rating.
- (e) Hydrogen gas emissions shall meet Mil-Spec #MIL-B-8565J

**CABLING/EXPANSION**

- (a) The UPS System shall utilize dedicated harnesses to connect the Electronics Module to the Power Interface Module and the Battery System. The harnesses shall use keyed, locking quick release connectors, and braided nylon jacketing over all conductors.
- (b) The UPS System shall have the capability of:
  - (1) Accepting an NTCIP-ready adapter, or
  - (2) Accepting a Spread-Spectrum Radio modem.
  - (3) Local and remote communications capabilities,
  - (4) Local or remote UPS control.

**ELECTRICAL**

- (a) Input Specifications:
  - (1) Nominal Input Voltage: 120 VAC, Single Phase
  - (2) Input Voltage Range: 85 VAC to 135 VAC (without drawing energy from batteries)
  - (3) Input Frequency: 50 or 60 Hz (+/- 5 percent)
  - (4) Input Configuration: Three (3) Wire (Phase, Neutral and Ground)
  - (5) Input Current (Max. draw): 16.5 amps, Power factor corrected
  - (6) Input Protection: Input Fuse (20 amps)

- (b) Output Specifications:
- (1) Nominal Output Voltage: 120 VAC, Single Phase
  - (2) Power Rating: 2.0KVA/1400W
  - (3) Output Voltage Regulation: +/- two (2) percent for 100 percent step load change and from High battery to Low battery condition
  - (4) Output Frequency: 50 or 60 Hz (+/- 5 percent)
  - (5) Output Configuration: Keyed, locking connectors
  - (6) Output Wave Form: True Sine wave
  - (7) Overload capability:
    - (a) 110% for 10 minutes
    - (b) 150% for 10 sec. per 45 sec. interval,
    - (c) 200% for .05 second
  - (8) Fault clearing: Current limit and automatic shutdown
  - (9) Short circuit protection: Current limit and automatic shutdown
  - (10) Efficiency: 85 percent at full load
  - (11) Load Power Factor: .7 lagging through unity to .7 leading

### **MECHANICAL, RACK-MOUNT UPS ELECTRONICS MODULE**

- (a) Dimensions: Width = 19" rack mount, Height = three (3) rack units
- (b) Weight: UPS: Less than 30 pounds.

### **ENVIRONMENTAL**

- (a) The UPS system shall meet or exceed NEMA temperature standards from -40 degrees C to +74 degrees C.
- (b) The UPS shall be certified and field proven to meet or exceed NEMA temperature standards. A certificate of compliance shall be made available upon request.

### **COMMUNICATIONS, CONTROLS AND DIAGNOSTICS**

- (a) Alarm Monitoring: The UPS system shall come standard with alarm monitoring, indicating:
  - (1) Loss of Utility Power,
  - (2) Inverter Failure, and
  - (3) Low Battery

- (b) An RS232 Interface shall be provided via screw terminals or a DB-9F connector allowing full, interactive, remote computer monitoring and control of the UPS functions.
- (c) Front Panel controls: Power ON, Cold (DC) Start, Alarm Silence, Battery Test, Bypass Breaker, and DC/Battery Breaker.

### **RELIABILITY**

- (a) Calculated MTBF is 100,000 hours based on component ratings.
- (b) 150,000 hours, when the Bypass and Power Interface Module are included.

### **OPTIONS**

- (a) Service pedestal-mounting option.
- (b) External dial-out modem for wireless or landline communication
- (c) Enhanced battery charger provides accelerated charging capacity.

### **SERVICEABILITY AND MAINTAINABILITY**

MTTR (Mean-Time-To-Replace or Repair): 15 minutes or less for all system components.

### **WARRANTY**

The UPS system shall carry a one-year guarantee from the date of delivery or installation against any imperfections in workmanship and material.

### **TRAINING**

Operational and Maintenance training for the entire system shall be provided to designated City personnel through the means of practical demonstrations, seminars, and other related technical teaching procedures. A minimum of eight (8) hours of instruction shall be provided. The training shall include the following:

- (a) "Hands on" operation of all UPS system hardware.
- (b) Explanation of the complete repertoire of system functions.
- (c) Instruction on required preventative maintenance procedures, and servicing procedures.

## ELECTRICAL DESIGN

### SOFTWARE

- (a) The City shall be given the right and shall have the authority through a non-disclosure agreement, to reproduce any furnished local controller unit, master controller unit, isolated traffic signal surveillance unit and remote reporting device proprietary software without payment of royalties.
- (b) The City shall be given the all of the software revisions for furnished local controller units, master controllers and isolated traffic signal surveillance units throughout the life of the contract.
- (c) No payment from the City shall be made for such software added features, enhancements, options, revisions or removal of errors or associated labor.
- (d) The City will make payment for any hardware related modifications or changes due to software added features, enhancements, options, revisions or removal of errors.

### COMPONENTS

- (a) All input/output pin connectors shall be fully wired and fabricated from metal. Plastic pin connectors are not acceptable.
- (b) All circuitry and components located on all printed circuit boards shall be intrinsically mildew and fungus growth resistant or be treated with a moisture resistant material to prevent damage from mildew and fungus growth.
- (c) All keypads, indicator lights, displays, input-output connectors, fuse holders, and other components that are pertinent to the operation, adjustment, and maintenance shall be located on the front panel.
  - (1) All of the above shall be labeled in such a manner as to provide easy identification of their appropriate function.
  - (2) All indicators and displays shall have a minimum  $\pm 45^\circ$  cone of visibility with the axis perpendicular to the front panel.
  - (3) All indicators and displays shall sufficient intensity to be readable up to four (4) feet within the cone of visibility in all lighting conditions without the use of additional shading.
- (d) Keypads shall have tactile and audible feedback to indicate that a key press has been registered. Membrane-type keyboards are not acceptable.
- (e) A listing of all parts used in furnished equipment, containing the following information, shall be supplied upon Notice to Proceed.

- (1) Commercially Available Part Number
  - (2) Manufacturer's Part Number
  - (3) The manufacturer's part number, indicated on the wiring diagrams and schematics.
- (f) The following fasteners SHALL NOT be used in any assembly unless specifically allowed by the specification.
- (1) Expanding Bushing
  - (2) Internal Self-Expanding
  - (3) Plastic Material
  - (4) Pop Rivets
  - (5) Self-Tapping Screws
  - (6) Split Shafts
- (g) To the highest practical degree, all equipment furnished shall be engineered for simplicity, ease of operation and maintenance.
- (1) No controls or switches shall be mounted concentrically.
  - (2) Controls or switches shall be separated by 0.5 inch minimum.
  - (3) Knobs shall be 0.5 inch minimum diameter.
  - (4) All fuses shall be enclosed and easily accessible for replacement without the use of tools.
  - (5) Printed circuit boards shall slide smoothly into their guides during installation or removal.
    - (a) Printed circuit boards shall require a force no less than 5 pounds or greater than 50 pounds for installation or removal.
    - (b) Printed circuit boards shall fit snugly into the printed circuit board connectors.
- (h) The following practices shall be incorporated into the design of solid state equipment circuitry.
- (1) The design shall be inherently temperature compensated to prevent abnormal operation.
  - (2) The circuit design shall include compensation necessary to overcome adverse temperature effects in the NEMA TS 2-1992 specified environmental range.
  - (3) All equipment with electrical potential greater than 25 volts to ground shall be protected from human contact.
  - (4) All equipment shall be designed to prevent reversed assembly or installation of connectors and assemblies where a possible malfunction could create a shock hazard to service personnel.

- (5) Any equipment furnished which has special or unique characteristics (except temperature variation of value) that would limit the supply of such equipment to a single manufacturer or supply source shall be stocked by the successful bidder in sufficient quantities for the maintenance of all equipment furnished under this contract.
- (6) No furnished equipment shall emit an audible noise greater than 55 db (A).
- (7) Capacitors shall be insulated and marked with their capacitance value and working voltage.
- (8) Capacitor encasements shall be resistant to cracking, peeling and discoloration.
- (9) Capacitors shall be of the best commercial grade with high stability, low dissipation and linear temperature coefficients.
- (10) The alternating current ratings, direct current ratings and dissipation factor shall exceed the worst case design of the circuitry by 150 percent.
- (11) Electrolytic capacitors may be used for  $\geq 1.0$  microfarad capacitance values and shall have the polarity indicated.
- (12) Capacitors less than 1/10 ounce weight may be secured by their leads if the total lead length in two (2) inches maximum.
- (13) Resistors shall be insulated and marked with their resistance value as specified by EIA color codes.
  - (a) Resistors shall have a tolerance value of 10 percent maximum.
  - (b) Completed resistor installations shall be rated and placed to not exceed the maximum service condition under the highest altitude for the State of Maryland at any point on the resistor.
  - (c) Resistor rated wattage shall be five (5) watts maximum.
  - (d) Resistors rated greater than two (2) watts shall only be used with special ventilation or heat sinking.
  - (e) Resistors rated greater than two (2) watts shall be insulated from printed circuit boards.
  - (f) Resistors less than 1/2 ounce weight may be secured by their leads if the total lead length in two (2) inches maximum.

- (14) Two (2) or more discrete components shall be individually replaceable, easily accessible for testing and maintenance and shall not be encapsulated except for the following.
  - (a) Diode Arrays
  - (b) Optical Isolators
  - (c) Resistor Networks
  - (d) Solid State Switches
  - (e) Transient Suppression Circuits
  - (f) Transistor Arrays
- (15) Germanium diodes will be permitted only when a low forward voltage drop is required in logic circuits.
- (16) All transistors, integrated circuits and diodes shall be listed EIA standard type.
- (17) All LSI device pin "1" locations shall be marked on both printed circuit board sides adjacent to the each pin.
- (18) All solid state devices shall be of silicon type.
- (19) All power as well as forward and reverse current and voltage ratings of semiconductor devices shall be  $\geq 20$  percent greater than the maximum design requirements of the circuit.
- (20) Jumper wires shall not be routinely used.
  - (a) Jumper wires shall be no longer than one (1) inch in length.
  - (b) Jumper wires shall not cross a bare conductor.
  - (c) Jumper wires shall be insulated if longer than  $\frac{1}{2}$ ".
  - (d) Jumper wires shall be on the component side only.
  - (e) Sleeves shall not be used as insulation on jumper wires.
  - (f) The following defects shall be cause for rejection of a printed circuit board.
    - (1) Abraded, Scratched or Scraped Finish effecting the Electrical Resistance
    - (2) Base Material Delaminating
    - (3) Conductor Pattern Blisters
    - (4) Conductor Pattern Separation from the Base Material
    - (5) Conductor Pattern Wrinkles
    - (6) Dirt or Foreign Matter on the Printed Circuit Board
    - (7) Flow Soldering more than two times

- (8) Pinholes, Pits, Scratches or Undercutting than will reduce Conductor Cross Sectional Area by More than 25 percent.
- (g) The following defects shall be cause for rejection of a printed circuit board solder connection.
  - (1) Burning, Charing, Wicking or Other Insulation Damage
  - (2) Cold Solder Connection
  - (3) Cut, Nicked, Scraped or Scratched Leads or Wires
  - (4) Disturbed Solder Connection
  - (5) Dewetted Transmission
  - (6) Excessive Solder Obscuring the Connection
  - (7) Excessive Wicking
  - (8) Holes, Pits or Scars
  - (9) Insufficient Solder
  - (10) Leads Cinched Together
  - (11) Loose Leads or Wires
  - (12) Rosin Solder Connection
  - (13) Solder or Flux Spatter on Adjacent Components or Connections
  - (14) Solder Peaks
  - (15) Unclean Solder Connection (Dirt, Grease, Residue or Solder Splash)
  - (16) Visible Bare Copper
  - (17) Soldered joints shall not be subjected to mechanical loads.

### **UPS FIELD EQUIPMENT CABINET**

The Contractor shall furnish and install a NEMA Size five (5) field equipment cabinet with each UPS system, or the UPS system shall be installed in a NEMA Size "S" cabinet along with the traffic signal controller equipment. The Contractor may provide the cabinet, or it may be supplied by the UPS manufacturer with or without the equipment pre-installed in it.

### **MATERIALS**

Electrical/electronic equipment, cabinets, and all component parts shall meet the requirements as specified in Section 820.02 and the standards as set forth in these special provisions:

- (a) Anchor bolts/Bolts/Nuts/Washers
- (b) Cabinets and doors
- (c) Mounting hardware
- (d) Electrical wires, harnesses and connectors.

**CONSTRUCTION****CABINETS: GENERAL**

- (a) Serial numbers, model numbers, the manufacturer's name and production date shall be clearly legible and permanently placed on all cabinets, battery back-up device mainframes and all removable printed circuit boards from the aforementioned equipment.
  - (1) The use of adhesive backed labels is not acceptable.
  - (2) The serial number and model number shall be etched, stamped, or molded on all printed circuit boards.
  - (3) Printed circuit board serial numbers, model numbers, the manufacturer's name and production date shall be marked by the same process used in making the conductor pattern.
  - (4) Printed circuit marking shall not be affected by any soldering or cleaning process solvents.
- (b) Cabinet and mainframe labels shall be 0.008 inches anodized aluminum and riveted by 0.125 inches stainless steel rivets onto the cabinet or mainframe.
- (c) Cabinet and mainframe labels shall be a minimum of two and one half inches width and 0.75 inches height.
- (d) The label shall incorporate a bar code with a City defined code number.
  - (1) This bar code number may be different for each device furnished.
  - (2) Mainframe serial numbers and model numbers shall be readable without disassembly or removal of any part of the cabinet or components located within the cabinet and located on the front face of the mainframe unit.
  - (3) Cabinet serial numbers, model numbers, the manufacturer's name and production date shall be readable without disassembly or removal of any part of the cabinet or components and shall be located on the right upper cabinet interior side.
- (e) All cabinets shall be provided with a vinyl print holder or approved equivalent, mounted on the inside of the cabinet door, suitable for holding a copy of the complete cabinet wiring diagram and other circuit diagrams that might be necessary to troubleshoot the entire cabinet assembly.

**CABINETS: MECHANICAL**

Cabinets shall be NEMA Size five (5) with dimension of thirty inches in width by fifty inches in height by eighteen inches in depth (30" W x 50" H x 18" D). The top of the cabinet shall have a depth of twenty (20) inches to provide the necessary ventilation opening) and have a anchor bolt pattern of twenty-five and three quarters inches in width by twelve and three eights inches in depth (25 ¾" W x 12 3/8" D).

- (a) All cabinets shall meet or exceed the requirements of a NEMA 3R rating and shall be UL listed as a unit.
- (b) All cabinets and doors shall be fabricated from 5052-H32 sheet aluminum alloy with a minimum one eighth of an inch (1/8".) thickness.
- (c) All mounting hardware and cabinet bracing shall also be made from aluminum.
- (d) All external welds shall be made using the Tungsten Inert Gas (TIG) welding method.
- (e) All main cabinet doors shall be provided with a dust tight gasket. The gasket shall be 0.25 inches minimum thickness closed cell neoprene or silicone and shall be permanently bonded to the metal.
- (f) If neoprene is used the mating surface of the gasket shall be coated with a silicone lubricant to prevent sticking to the metal mating surface.
- (g) A gasket top channel shall be provided to support the top gasket on the main door.
- (h) All cabinet doors shall be hinged on the right side as viewed facing the cabinet.
- (i) Batteries shall be installed on shelves, at least 6 inches above the cabinet foundation. Batteries shall not be installed directly on concrete foundations.
  - (1) Each battery shelf shall be capable of withstanding the aggregate weight of the batteries on that shelf with a Factor of Safety of 2.00, minimum.
  - (2) If the standard cabinet shelves cannot provide this capability, additional bracing or reinforcement shall be provided to bring them into compliance with this specification at no extra cost to the City.
  - (3) Shop drawings and calculations for any required shelf reinforcement shall be reviewed and approved by the City Engineer prior to fabricating the cabinets.

**CABINETS: ELECTRICAL**

- (a) All conductor wire runs shall be continuous with no splices.
- (b) All wiring harnesses shall be encased in a continuous sheath. The use of cable ties to arrange wiring harnesses is not acceptable. The use of adhesive backed wire holders is also not acceptable.

- (c) All cabinet back and panel harness wiring shall be soldered at its destination point as specified.
- (d) All conductors shall be labeled. Labels shall be either attached to each end of the conductor and indicate the destination of the other end of the conductor, or shall be a continuous, permanent identification of the conductor's function and located every six inches along the conductor.
- (e) All conductors used in the controller cabinet wiring shall conform to the following color code requirements.
  - (1) AC Neutral conductors shall be identified by a continuous white color.
  - (2) AC Ground conductors shall be identified by a continuous green color.
  - (3) AC Positive conductors shall be identified by a continuous black color.
  - (4) All other conductors shall be identified by any color not previously specified.
- (f) All bolts used for electrical connections shall be fabricated from stainless steel.
- (g) All hardware used for electrical connections and terminal facilities shall be fabricated using cadmium plated brass.
- (h) All fuse holders shall be of the encased type.
- (i) All switches shall be encased, environmentally sealed, and rated for one hundred and twenty-five percent of capacity. Switches and thermostats shall break the "hot" side of the line
- (j) All welds shall be neatly formed and free of cracks, blow holes and other irregularities.
- (k) All inside and outside edges of the cabinet shall be free of burrs.
- (l) All access door openings shall have a double flange on all four sides.
- (m) All cabinet door hinging shall be of a single, continuous design utilizing a fixed hinge pin.
- (n) All cabinet door hinge pins shall be capped at the top and bottom by weld to render the pin tamper proof.
- (o) All cabinets shall have a rear sloped top surface to prevent the accumulation of water on the top surface of the cabinet.
- (p) Cabinets shall have a three (3) inches width flange inside the cabinet for anchor bolt and/or bottom plate mounting.
- (q) Cabinets shall have four (4) open end slotted anchor bolt openings one (1) inch diameter into the cabinet conduit entrance area in lieu of NEMA TS 2-1992 figure 7.7.3-1.
- (r) Cabinets shall be furnished with four (4) anchor bolts sized as per NEMA TS 2-1992 section 7.8.4.

- (s) Cabinets shall be furnished with a one (1) inch thickness neoprene gasket so that the gasket forms a weather tight seal between the cabinet base mounting and in-field concrete base.
- (t) Cabinets shall have a three point latching mechanism of the draw roller type.
  - (1) The pushrods shall be turned edgewise at the outward supports
  - (2) The pushrods shall have a cross section of 0.25 inches by 0.75 inches.
  - (3) The locks and handles shall be on the left of the main cabinet door.
  - (4) The center latch cam shall be designed to allow only the door to open when the handle is moved towards the center of the door.
  - (5) The pushrod end rollers shall have a 0.875 inches minimum diameter.
- (u) All cabinets shall include a door restraint to restrict the door to a maximum one hundred and thirty-five degrees (135°) of swing in addition to stop positions specified in NEMA TS 2-1992 section 7.5.3.
- (v) Cabinets shall be furnished with a dead bolt type version of the lock specified in NEMA TS 2-1992 section 7.5.4.3 and a key hole cover. The dead bolt lock shall be keyed for a "Number 2" key.
- (w) Cabinets shall be provided with louvered vents in the front door with a removable air filter.
  - (1) Louvers shall satisfy the NEMA Rod Entry Test for a 3R rated ventilated enclosure.
  - (2) Cabinets shall have a filter sized sixteen inches in width by twelve inches in height by one inch in thickness (16" W x 12" H x 1" T).
  - (3) The filter shall cover the vents and be held firmly in place with top and bottom brackets and a spring loaded upper clamp.
- (x) Exhaust air will be vented out of the cabinet between the top of cabinet and the main access door via an exhaust plenum
  - (1) The exhaust area shall be screened with a material having a 0.125 inches maximum whole diameter.
  - (2) Dual fans shall be mounted at the top of the cabinet onto an exhaust plenum in lieu of NEMA TS 2-1992 section 7.9.2.2 location requirements.
  - (3) The fans and thermostat shall be rated for one hundred and twenty-five percent (125 percent) of capacity.
    - (a) The fan bearing mechanism shall be of ball bearing design.
    - (b) The fan shall have a minimum rated design life of one hundred thousand hours (100,000 hours).

**DOCUMENTATION**

The UPS system supplier shall provide three sets of operating manuals, service manuals, wiring diagrams, schematics, and maintenance instructions for all components of the UPS system, including the cabinet. In addition, the UPS System supplier shall provide a fourth set of schematics and wiring diagrams which shall be furnished in the wiring diagram holder in the controller cabinet. This documentation shall include:

- (a) General Characteristics and Description
- (b) Assembly and Installation
- (c) Logic and Schematic Diagrams including Integrated Circuits. Schematics shall include a list of tests points with the following information provided for each point:
  - (1) Nominal operating voltage.
  - (2) Wave form and all pertinent information regarding the waveform at each test point.
  - (3) Theory of Operation
  - (4) Detailed Circuit Operation Description
  - (5) Systems Operation with Block Diagram
  - (6) Connection and I/O diagrams.
- (d) Illustrated parts list with industry standard part numbers where applicable.
- (e) Maintenance Operations
  - (1) Alignment Procedures
  - (2) Preventive Maintenance
  - (3) Trouble Analysis
  - (4) Trouble Shooting Sequence Chart
  - (5) Voltage Measurements
  - (6) Wave Forms

**EXPERIENCE**

The manufacturer shall provide the names, addresses, and telephone numbers of at least three transportation agencies in the U.S. currently using the manufacturer's UPS System. The agencies so named shall confirm that the manufacturer's systems have operated as specified in their contract documents and any applicable revisions for a period of at least one year, and that all maintenance agreements and/or warranties have been honored.

**MEASUREMENT AND PAYMENT**

Backup UPS systems shall be measured and paid for at the contract unit price each, which shall include the complete UPS system, NEMA Size five (5) cabinet and base, all batteries and harnesses, installation, electrical work, grounding, and all other incidentals. If the UPS is installed in a NEMA Size S cabinet the price shall only be for the UPS, all batteries and harnesses, installation, electrical work, grounding and other incidentals. The payment shall be full compensation for all materials, labor, equipment and all other incidentals necessary to complete this work.

**SPECIFICATION FOR**  
**HIGH DEFINITION IP BASED VIDEO TRAFFIC DETECTION CAMERAS**

**DESCRIPTION.** Furnish and install self contained high definition (HD) Internet Protocol (IP) based video detection cameras that monitor vehicles on a roadway via the integrated video sensor with embedded camera-processor for analysis of color video images, and provide outputs to a traffic controller or similar device, as well as streaming video over a common ethernet connection, as specified in the Contract Documents or as directed by the Engineer.

**MATERIALS.** Provide video traffic detection cameras, mounting hardware, cabinets, and all component parts that meet the latest edition of the National Electrical Manufacturers Association (NEMA) Standards and Underwriters Laboratory (UL), as applicable. Provide ISO 9002 and CE certified camera components. Use the advertising date of this Contract to determine the date of the applicable standards.

If available, permanently engrave serial numbers and model numbers on all removable components and hardware. Etch, Stamp or mold the serial number and model number. The use of adhesive backed labels is not acceptable.

**Features.**

- (a) Built-in IP based addressing with a unique Ethernet MAC address. No plug-in devices or cards shall be necessary.
- (b) Integrated high definition color camera with remote controllable zoom lens.
- (c) Phase color input support for delay on red and extend on green on a detection zone basis.
- (d) Web-server interface and network connection via standard RJ-45 Ethernet port through CAT 5, CAT 5E or CAT 6 Ethernet cable.
- (e) Easy locking connector that allows technicians/installers to pull power cable either up or down a pole without splicing
- (f) Zoom configuration may be conducted at the cabinet or remotely over Ethernet.
- (g) H.264 streaming video via any standard digital video player, with variable selectable bit rate.
- (h) 16x9 video format which provides a wider field of view.
- (i) Tracking algorithm technology for increased detection accuracy.

**Camera Hardware.** Supply hardware that consists of a color video image processing camera a 3-

wire control & data transfer cable for signal control and streaming video image transfer and a City installed communication manager interface panel.

**Video Sensor.** Provide video detection system including video sensor that integrates a high definition camera with an embedded processor for analyzing the video and performing detection bundled into a sealed enclosure.

**(a) Camera and Processor:**

- (1) Color CMOS imaging array
- (2) Resolution: 720p minimum (1280 x 720 pixels)
- (3) Optical Zoom: 10X minimum
- (4) Focal Length: 3.8mm to 38mm
- (5) Field of View: Horizontal: 7.6 to 67 degrees
- (6) Field of View: Vertical: 4.3 to 37.7 degrees
- (7) Sensitivity: 1.4 Lux
- (8) Signal to Noise Ratio: Less than 50 db
- (9) Zoom must allow across-the-intersection detection objectives, including stop line and advanced detection.
- (10) Remotely control zoom from the traffic management center or local user maintenance via Ethernet. It shall be possible to zoom the lens as required for setup and operation.
- (11) Direct, real-time iris and shutter speed controlled by the integrated processor.
- (12) Processor shall support H.264 video compression for streaming output with variable bitrate (100 to 5,000 Kbps).
- (13) Image Format: 16x9

**(b) Video Sensor Enclosure Assembly**

- (1) Camera and Processor Enclosure Rating: Sealed IP-67 enclosure
- (2) Glass faceplate with Hydrophilic faceplate coating to shed water, reduce debris accumulation and reduce maintenance.

- (3) Thermostatically-controlled Indium Titanium Oxide (ITO) heater applied directly on the interior surface to keep faceplate clear of condensation, snow, ice and frost.
- (4) Adjustable aluminum visor.
- (5) Integral sight to assist with aiming detector during setup.
- (6) Removable cap and cable strain relief to seal the power connector. Rear cap tethered to enclosure. Rear cap shall be fastened to body of video sensor with single captive bolt. Rear cap and enclosure shall include gore breathers to equalize internal and external pressure.
- (7) Self supporting sensor on manufacturers mounting bracket.
- (8) Allow 360 degree field of view rotation without changing angle of visor.

(c) Power and Communications

- (1) Power and communications including digital streaming video output and all data communications shall be transmitted over the three-conductor power cable. Coaxial cable not required.
- (2) Termination of three-conductor cable shall be inside the rear cap of enclosure on a three-position, removable terminal block. Each connector shall attach to the terminal block via a screw connection.
- (3) No supplemental surge suppression required outside the cabinet.

(d) Environmental:

- (1) Temperature: -29° to +165°F
- (2) Relative Humidity: In accordance with TS2 standards

(e) Dimensions:

- (1) Height: 7 inches
- (2) Width: 5.5 inches
- (3) Length: 22.5 inches
- (4) Weight: 6.5 lbs

**(f) Electrical:**

- (1) Power Input: 89VAC to 265VAC, 60Hz or 50 Hz
- (2) Power Consumption: Typical 13W to 15W, Maximum 18W (with heaters on).

**(g) Regulatory:**

- (1) FCC Part 15, Class A
- (2) ICES
- (3) EN55022, EN55024, EN61000-6-1
- (4) NEMA TS2-2003

**Detection Zone Programming and Management Software.** Placement of detection zones, management of video sensors and configuration shall be by means of a portable laptop or desktop computer using the Windows 7 or 10 operating system, a keyboard, and a mouse. Software will communicate with the video detection system via Ethernet.

- (a) The PC monitor shall be able to show the detection zones superimposed on images of traffic scenes.
- (b) Software will automatically determine all video sensors and communication management interface panels available on the local network and populate a list of devices. The software will support assignment of names to video sensors.
- (c) User may zoom camera while viewing live video stream via management software.
- (d) Calibration of distances in the field of view may be completed via management software.
- (e) Software will provide a screen to monitor operation of a video sensor including high definition (1280x720) pixel resolution. The monitoring screen will provide indications of detection in real-time by changing the color of the detector. Software will provide the ability to monitor operation of the intersection with a quad-view video stream from the communication manager interface panel. Software will allow recording of a single video sensor or quad-view and the ability to save the file to the PC.
- (f) The mouse and keyboard shall be used to draw detection zones on the PC monitor. It shall be possible to:
  - (1) Download detector configurations from the PC to the video sensor and communication manager interface panel cabinet equipment.
  - (2) Retrieve the detector configuration that is currently running on a video sensor.

- (3) Back up detector configurations by saving them to the PC fixed disks or other removable media storage.
  - (4) Read or import all settings from a previously saved configuration file for a video sensor or communication manager interface panel
- (g) The mouse and keyboard shall be able to:
- (1) Edit previously defined detector configurations by altering size, shape or name.
  - (2) Adjust the detection zone size and placement.
  - (3) Add detectors for additional traffic applications.
  - (4) Reprogram the camera for different traffic applications, changes in installation site geometry, or traffic rerouting.
  - (5) Perform the above upload, store, and retrieve functions for video snapshots of the video sensor cameras view.
  - (6) Place detection zones anywhere in the field of view.
  - (7) Set desired color of detections in the on and off state.
  - (8) Assign each zone to detect vehicles, bicycles or both.
  - (9) Assign the same output to multiple zones such that the output will be on if any of the zones are detecting a vehicle or bicycle.
  - (10) Assign a single zone to more than one output.
  - (11) Program at least 99 detection zones per video sensor.

**Optimal Detection.** Provide video detection camera that provides optimal detection of vehicle passage and presence when the:

- (a) Video sensor is installed on lighting arm or mast arm across the intersection for presence (stop line) detection.
- (b) Video sensor is located horizontally on a mast arm or luminaire arm in a level position and aligned with the approaching lane.
- (c) Video sensor is mounted between 18 feet and 30 feet above the roadway. Generally the high

the camera is mounted, the better the view and detection coverage.

- (d) The distance to the farthest detection zone locations is not greater than 15 times the mounting height of the video sensor.
- (e) The deployment geometry provides an unobstructed view of each traveled lane where detection is required. Although optimal detection may be obtained when the video sensor is mounted directly above the traveled lanes, the video sensor shall not be required to be directly over the roadway.
- (f) The video sensor is able to view either approaching or receding traffic or both in the same field of view. The preferred image camera orientation for optimal detection shall be to view approaching traffic since there are more high contrast features on vehicles as viewed from the front rather than the rear.
- (g) The video sensor, when placed at a mounting height that minimizes vehicle image occlusion, is able to monitor a maximum of 7 traffic lanes when mounted at the roadside, or up to 8 lanes when mounted in the center with four lanes on each side.

**Count Detection Performance.** Using a video sensor installed within the optimal viewing specifications for count station traffic applications; the camera shall be able to accurately count vehicles, and store traffic flow data in non-volatile memory for later retrieval and analysis, with:

- (a) At least 98 percent accuracy under normal operating conditions (day and night).
- (b) No additional hardware or software required.
- (c) At least 93 percent accuracy under artifact conditions. Artifact conditions are combinations of weather and lighting conditions that result from shadows, fog, rain, snow, etc. The volume count shall be:
  - (1) Accumulated for the entire roadway (all traveled lanes).
  - (2) Accumulated over time intervals that contain a minimum of one hundred (100) vehicles to ensure statistical significance.

**Demand Presence Detection Performance.** Using a video sensor installed within the optimal viewing specifications described above for intersection control traffic applications; the video sensor shall be able to accurately provide demand presence detection.

- (a) The demand presence accuracy shall be based on the ability to enable a protected turning movement on an intersection stop line, when a demand exists.
- (b) The probability of not detecting a vehicle for demand presence (stop line) shall be less than 1

percent error under all operating conditions.

- (c) The probability of falsely detecting a vehicle that is not there for demand presence (stop line) shall be less than 3 percent error under all operating conditions.
- (d) To ensure statistical significance, the demand presence accuracy and error shall be calculated over 24 hour time intervals that contain a minimum of 100 vehicles per lane.
- (e) The calculation of the demand presence error shall not include turning movements where vehicles do not pass through the presence detectors, or where they stop short or stop beyond the combined detection zones.

**Failsafe Mode.** The video sensor will provide three failsafe options during optical contrast loss. The default will be maximum recall. The video sensor may be configured to use minimum recall or fixed recall, which is a user-defined number of seconds entered to hold a call, for failsafe mode.

The sensor continuously monitors the overall contrast in the video. If the overall contrast falls below the preset level due to dirt on faceplate, extreme fog, severe glare or ice on faceplate, the sensor will enable the chosen failsafe mode. After contrast is restored, the video sensor will exit failsafe mode.

The communication manager interface panel continuously monitors the connectivity status of the attached video sensors. If any video sensor goes offline due to electrical failure or internal software failure, the communication manager interface panel shall enable failsafe mode. Once the video sensor is back online, the device will exit failsafe mode.

**Speed Detection Performance.** The video sensor shall accurately measure average (arithmetic mean) speed of multiple vehicles with more than 97 percent accuracy under all operating conditions for approaching and receding traffic.

- (a) The average speed measurement will include a minimum of 100 vehicles in the sample to ensure statistical significance.
- (b) Optimal speed detection performance requires that camera location conform to the specifications described for count station traffic applications with the exception that the camera must be higher than 30 feet.
- (c) The video sensor will accurately measure individual vehicle speeds with more than 94 percent accuracy under all operating conditions for vehicles approaching the camera (viewing the front end of vehicles), and more than 90 percent accuracy for vehicles receding from the camera (viewing the rear end of vehicles).
- (d) These specifications will apply to vehicles that travel through both the count and speed detector pair and will not include partial detection situations created by lane-changing maneuvers.

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

**18-Gauge Camera-to-Cabinet Cable.** The cable between the MVP and the cabinet interface shall consist of three conductors 18 AWG, with an overall UV-resistant low density polyethylene jacket.

**(a) Conductors.**

- (1) Three, 18 AWG, 19 strands of 30 gauge tin-plated copper conductor diameter .046”/.052”.
- (2) Extruded polyethylene 200 conductor insulation, with nominal .030” wall thickness.
- (3) Black, green, and white colors.

**(b) Construction.**

- (1) Extruded black polyethylene jacket .040”/.050” wall thickness, UV-resistant.
- (2) 0 .330” - .354” maximum outside diameter.
- (3) 600 volt (rms) rated.
- (4) The cable shall be imprinted with the manufacturer’s part number, number of conductors, conductor size, voltage rating, jacket material, and an indication that it is conduit rated.

**Communication Manager Interface Panel.** The video detection system will include an interface panel in the traffic signal cabinet that manages communications between video sensors, the traffic management center, a maintenance technical and the traffic signal controller. The communication manager interface panel will be furnished and installed by the City. This section is for reference only.

The communication manager interface panel cabinet equipment shall provide connection points and communicate directly with up to four (4) video sensors (cameras) and provide up to thirty-two (32) inputs and sixty-four (64) outputs or up to sixteen (16) contact closure inputs and twenty-four (24) contact closure outputs to a traffic signal controller.

The communication manager interface panel shall have the following features:

- (a) Four (4) sets of three (3) electrical terminations for three-wire cables for power and broadband-over-power communications for up to four (4) video sensors cameras.
- (b) High-energy transient protection to electrically protect the communication manager interface panel and connected video sensors.
- (c) Predefined wire termination blocks for video sensor power and communication connections.

- (d) A broadband-over-power transceiver that supports up to 70 to 90 Mbps inter-device communications. A broadband-over-power transceiver that supports communication over a distance of at least 1,000 feet of cabling to the video sensor.
- (e) Power switch for each video sensor.
- (f) An LED for each video sensor indicating the state of power to the sensor.
- (g) An LED for each video sensor indicating the status of communication.
- (h) The option of using either 120/240 VAC 50/60 Hz power.
- (i) Fuse protection using two SLO-BLO fuses.
- (j) One (1) NEMA TS2 Type 1 compatible SDLC interface which consists of a 15-pin female metal shell D sub-miniature type connector to support a standard NEMA TS2 or TEES SDLC cable to provide communications between the communication manager interface panel and the traffic signal controller through the cabinet.
- (k) Supports a protocol interface to SDLC capable traffic controllers (NEMA or TEES).
- (l) Supports SDLC protocol including up to sixty-four (64) detector outputs and thirty-two (32) inputs.
- (m) SDLC connection capable of being wired to an input/output card which supports wired I/O in cabinets without an SDLC capable controller. Support at least twenty-four (24) outputs and sixteen (16) inputs via the wired I/O data communications link.
- (n) Capability to connect and use both SDLC communications and communications to the wired I/O card simultaneously.
- (o) 10/100/1000M Ethernet RJ-45 port for connection to traffic management center. Provide a communication manager interface panel which will proxy all network requests that arrive on the traffic management center connection to avoid unwanted network traffic from reaching the broadband-over-power network between the communication manager interface panel and the video sensors. A single IP address will be used for all communications through the traffic management center connection to the video detection system.
- (p) Local user maintenance communications will be via a 10/100/1000M Ethernet RJ-45 port to connect the technician at the cabinet to the video detection system for maintenance purposes. A single IP address will be used for all communications through the local user maintenance connection to the video detection system. The local user maintenance port shall support DHCP to automatically assign an IP address to a maintenance user computer, if desired.

- (q) 802.11g WiFi access point to allow wireless connection to the video detection system at the cabinet for setup and maintenance purposes. The WiFi access point communicates to the video detection system through a single IP address and must support DHCP to automatically assign an IP address to a maintenance user computer, if desired. The WiFi access point consists of a dipole omnidirectional antenna. WiFi access point equipped with a momentary on/off switch. After a period of inactivity, the WiFi access point will turn itself off. An LED will indicate the status of the WiFi access point. The WiFi access point shall have the ability to operate simultaneously with the RJ-45 Ethernet ports for traffic management center and local user maintenance communications.
- (r) Two (2) USB 2.0 ports. USB ports capable of running software to reinstall system and application software from a USB memory stick without removal of the communication manager interface panel.
- (s) Environmental:

  - (1) Temperature: -29° to +165°F
  - (2) Relative Humidity: 0-95% non-condensing
- (t) Dimensions:

  - (1) Height: 2.5 inches
  - (2) Width: 7 inches
  - (3) Length: 11 inches
  - (4) Weight: 2.0 lbs
- (u) Electrical:

  - (1) Power Input: 85VAC to 265VAC, 60Hz or 50 Hz
  - (2) Power Consumption: Minimum of 15W typical without sensors; 75W typical with 4 video sensors; 140W maximum
- (v) Video Output:

  - (1) Digital Streaming: H.264 720p, 30 fps
  - (2) Variable bitrate selectable (100 to 5,000 Kbps)

**(w) Regulatory:**

- (1) FCC Part 15, Class A
- (2) ICES
- (3) EN55022, EN55024, EN61000-6-1
- (4) NEMA TS2-2003

**Wired Input / Output (I/O) Card.** The video detection system will support an optional wired I/O card that communicates with the communication manager interface panel for real-time detection states and other I/O to the traffic signal controller. The wired I/O card may reside in a standard detector rack or shelf mount enclosure with power module. The wired I/O card will be furnished and installed by the City. This section is for reference only.

The wired I/O card will provide up to sixteen (16) contact closure inputs and twenty-four (24) contact closure outputs to a traffic signal controller.

The wired I/O card shall have the following features:

- (a) Comply with form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack or Caltrans TEES input file.
- (b) Occupy two slots of the detector rack.
- (c) Provide four (4) detector outputs on the rear-edge connector.
- (d) Provide a front connector which allows up to sixteen (16) contact closure inputs and twenty-four (24) contact closure outputs to a traffic signal controller.
- (e) A front panel LED for each of the sixteen (16) contact closure inputs and twenty-four (24) contact closure outputs to indicate the state of each detector.
- (f) Supports optional expansion cards in other slots. Each expansion card supports four (4) outputs to the back edge of the card.
- (g) Optional harness for connection to input files or C1, C4, C11 and C12 ports to support Type 170 or Type 2070 controllers.
- (h) Hot swappable card.
- (i) DB-44 pin connector that may connect the I/O harness from the cabinet to the wired I/O card including sixteen (16) inputs and twenty-four (24) outputs.

(j) DB-9 pin connector to provide connection to communication manager interface panel.

(k) Environmental:

(1) Temperature: -29° to +165°F

(2) Relative Humidity: 0-95% non-condensing

(l) Dimensions:

(1) Height: 4.5 inches

(2) Width: 2.3 inches

(3) Length: 6.9 inches excluding handle

(4) Weight: 0.5 lbs

(m) Electrical:

(1) Power Input: 10.8 VDC minimum; 26.5 VDC maximum

(2) Power Consumption: 50ma per channel

(n) Video Output:

(1) Digital Streaming: H.264 720p, 30 fps

(2) Variable bitrate selectable (100 to 5,000 Kbps)

(o) Regulatory:

(1) FCC Part 15, Class A

(2) ICES

(3) EN55022, EN55024, EN61000-6-1

(4) NEMA TS2-2003

**CONSTRUCTION.** Provide video detection cameras that consist of an HD IP based video camera and a 3-conductor power cable that carries both power to the camera, and video and data signals back to Contractor installed video detection communication manager interface equipment in the controller

cabinet. The video detection communication manager interface equipment installed in the cabinet permits direct communication to the traffic signal controller using the industry standard EIA-485 synchronous data link (SDLC) or to contact-closure hardwired devices. A 10/100/1000 Ethernet connection and the industry standard TCP/IP communications protocol allow connection to Ethernet/IP based networks.

**Mounting Hardware.** Supply mounting hardware capable of securely mounting the camera to the camera support and mounting the camera support securely to the structure. Provide mounting hardware capable of mounting the camera to a vertical, horizontal or angled structure in accordance with Maryland SHA Typical details. Provide a 60" vertical extension pipe when installing on a mast arms unless otherwise specified by the Contract Documents or as directed by the Engineer.

**Installation and Training.** The supplier of the video detection camera shall supervise the installation and testing of the video detection camera and any optional computer equipment.

**Warranty, Maintenance and Support.** The video detection camera shall be warranted by its supplier for a minimum of 3 years.

**Documentation.** The equipment supplier shall deliver a CD or USB drive containing operating manuals, service manuals, and maintenance instructions for the video traffic detection camera being supplied to the City's Signal Operations Division, located at 51 East Memorial Boulevard, Hagerstown, Maryland 21740. The phone number is 301-739-8577 x177.

**MEASUREMENT AND PAYMENT.** HD IP Based Video Traffic Detection Camera and Any Length Lead-In Cable will be measured and paid for at the contract unit price per each. The payment will be full compensation for furnishing and installing the video traffic detection camera, equipment specified, all mounting hardware including camera support to structure, up to 60" vertical extension pipe, 3 conductor cable from the camera to the controller cabinet, labor, and all incidentals necessary to complete this work.

The HD IP-Based Video Detection Communication Manager Interface Panel, wired input/output card (if specified) and all other cabinet equipment will be furnished and installed by the contractor.



**SPECIFICATION FOR  
SIGNAL HEADS**

**DESCRIPTION.** Furnish and install vehicle traffic control signal heads and pedestrian traffic control signal heads.

Furnish and install Aluminum and Polycarbonate 8-in. and 12-in. vehicle traffic control signal heads and hardware with LED Green, Yellow, and Red indications, as specified in the Contract Documents or as directed by the Engineer. All signal housing shall have a black face and black housing.

**MATERIALS.** Traffic Signal Heads 950.15

**CONSTRUCTION.** Aiming. Aim signal heads to be visible in conformance with the minimum requirements of the MdMUTCD.

LED Traffic Signal Modules	“Section 800 LED TRAFFIC SIGNAL MODULES”
ALL Red and Green Traffic Signals	COMAR 14.26.03
(LED or Incandescent)	(Certification of compliance with Maryland Energy Efficiency Standards)

**MEASUREMENT AND PAYMENT.** Aluminum, Polycarbonate, and Optically Programmed Signal Heads and Pedestrian Signal Heads furnished and installed will be measured and paid for at the Contract unit price per each section of signal head type and size as specified in the Contract Documents. The payment will be full compensation for all lenses, mounting hardware, assembly, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Aluminum and Polycarbonate LED Signal heads will be measured and paid for at the Contract unit price per each section of signal head type and size as specified in the Contract Documents. The LED signal heads will have the LED module fitted into the housing assembly. The payment will be full compensation for the housing, LED signal module, and, mounting hardware, assembly, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

**SPECIFICATION FOR  
TRAFFIC SIGNAL HEADS**

**TRAFFIC SIGNAL HEADS.** Pedestrian signal indications and vehicular signal heads shall meet the Institute of Transportation Engineers (ITE) Specifications.

- (a) All materials shall be clean, smooth, and free from flaws, cracks, blowholes, and other imperfections.
- (b) Signal heads shall be furnished with the section assembled together including all hardware as specified in the Contract Documents.
- (c) All metallic signal head hardware shall be stainless steel material.
- (d) Vehicular, optically-programmed and pedestrian signal heads shall be capable of mating to the same type of the signal heads from either the top or bottom of each housing.
- (e) All hardware furnished shall be installed on the corresponding fitting and threaded component.

Mounting hardware shall meet the following:

ITEM	DESCRIPTION	A	B	C	D
1	Aluminum Alloy - Casting	A 319	A 380	A 713	6063 T6
2	Yield Strength, ksi	18	23	25	25
3	Tensile Strength, ksi	27	47	35	30
4	Brinell Hardness	70	80	75	73
5	Elongation (% in 2 in.)	1.5	4	3	12
6	Stainless Steel	A 316	-	-	-
7	Galvanized Steel	A 157	A 153	G 60	-
8	Steel-Flat Sheet	16 gauge	-	-	-
9	Coating	*	Anodized Finish	-	-
10	Brass	CZ120	-	-	-

\* The pedestrian signal head housing shall be yellow in conformance with Federal Standards 595, Color Chip No. 13538. The pedestrian signal head door and visor shall be optical flat (dull) black Federal Standards 595, Color Chip No. 37038. The vehicular traffic signal head housing, door and visor shall be optical flat (dull) black Federal Standards 595, Color Chip No. 37038. Aluminum signal heads shall be painted using fusion bonded polyester coating method.

**Hardware.**

- (a) Hub plate shall conform to A, 1 thru 5 and 9B.
- (b) Span wire hanger clamp shall conform to C, 1 thru 5.
- (c) Balance adjuster body shall conform to 10A.
- (d) Balance adjuster eyebolt and hardware shall conform to 6A, 7A, and 7B.
- (e) 2-way lower arm shall conform to 7C and 8A.
- (f) 2-way tri-stud arm shall conform to A, 1 thru 5.
- (g) Span wire entrance fitting shall conform to C, 1 thru 5.
- (h) Mast arm mount signal bracket (1-way, 2-way, and 5-section) shall conform to 1A and 1D.
- (i) Side pole upper and lower arm assembly shall conform to 1B thru 5B or 1D thru 5D.

The maximum allowable play or space between the sides of the eyebolt and span wire clamp shall be 0.062 in.

#### **Vehicular Signal Heads and Pedestrian Signal Indications Housings and Doors.**

- (a) Aluminum signal head housings and doors shall be die-cast aluminum as specified in the ITE Vehicle Traffic Control Signal Head Specification.
- (b) Dual hinge-latch mechanisms shall be mounted on the signal head housing and not the signal head door. Captive door latch mechanisms (one for 8 in. and two for 12 in. vehicular signal heads, and one for 9 in. and two for 12 in. pedestrian signal indications) shall secure the door to the housing by use of stainless steel eyebolts and wing nut assemblies.
- (c) All openings to the housing interior shall be provided with a gasket meeting the physical properties listing in UL 508 and that forms a weather tight seal.

#### **Visors.**

- (a) Visors shall be as specified in the ITE Vehicle Traffic Control Signal Head Specification and shall be tunnel type. Visors shall be 10 in. deep for 12 in. vehicular signal heads, 8 in. deep for 8 in. vehicular signal heads, 9 in. deep for 12 in. pedestrian signal indications, and 9.5 in. deep for optically programmed signal heads.
- (b) Visors shall be secured to the signal head door by a minimum of four screws mounted perpendicular to the face of the signal head door.
- (c) Visors for aluminum vehicular signal and pedestrian signal sections shall be made from aluminum alloy sheet. Visors for polycarbonate signal sections shall be either formed from sheet plastic or

assembled from one or more injection, rotational, or blow-molded polycarbonate sections.

**Optical System.** Vehicular and pedestrian traffic control signal indications shall meet the following.

**(a) Signal Head Lamps.** Approved by the City of Hagerstown

**(b) Reflector.** Shall be made of aluminum. Reflector support assembly shall be die cast aluminum, separate from the reflector and fully encompass the periphery of the reflector.

Reflector support assembly shall be spring hinged to allow access to the rear of the signal head main body without the use of tools.

**(c) Lens.** Shall be standard (ball) red, yellow, or green, or specified arrow red, yellow, or green traffic signal lens. The lens shall be glass. Directional arrow lenses shall have the same brilliance, regardless which direction they are positioned in the signal face. The lens shall fit into a one-piece slotted neoprene lens gasket designed to provide a weather resistant fit to the housing door. Lenses shall be secured by a flat clip/screw design fastened from the inside of the signal head door perpendicular to the face of the door. The flat clip/screw design shall not pass through the lens itself. All pedestrian signal heads shall provide the messages of “walk” and “don’t walk” in the international walking person and the raised hand symbols.

**Optical System for Optically Programmed Signal Heads.**

**(a)** The indication from the lens shall meet the requirements of ITE transmittance and chromaticity standards.

**(b)** Optically programmed signal heads shall have an optical system containing a color filter, lamp fixture, lamp collar, optical limiter/diffuser, and objective lens.

**(c)** Lamp fixtures shall be comprised of a separately accessible housing and integral lamp support, indexed ceramic socket, and self-aligning and quick release lamp retainer. Electrical connection between case and lamp housing shall be accomplished with an interlock assembly that disconnects the lamp holder when opened.

**(d)** The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 900 to 1200 ft distance and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be composed of heat-resistant glass.

**(e)** Optically programmed signal heads shall utilize incandescent PAR type lamps. The lamp shall be coupled to the diffusing element.

The diffusing element may be discrete or integral with the convex surface of the optical limiter. **(f)** The objective lens shall be a high resolution annular incremental lens hermetically sealed within a flat laminate of weather resistant acrylic or as approved by Office of Traffic and Safety. The lens shall be symmetrical in outline and may be rotated to any 90 degree orientation about its axis without displacing the primary image.

**Electrical.**

- (a) The entire signal head assembly shall be either listed or labeled by a Maryland State Fire Marshall or a recognized electrical inspection agency.
- (b) Wiring connections at the lamp socket shall lock and not be of the male/female demountable type.
- (c) A unitized bail wire with integral spring shall secure the socket to the rear of the reflector. The lamp socket shall have a serrated base to permit locking.
- (d) Each single section and the middle section of three section signal heads shall have a minimum of a six section, twelve position terminal block capable of accepting three number 14 AWG spade terminal ends. The top section of two section pedestrian signal indications shall be furnished with a minimum of five section, ten position terminal blocks capable of accepting three number 14 AWG spade terminal ends.
- (e) Optically programmed signal heads shall not contain a resistance device for use as an intensity controller with integral means for regulating its intensity between limits as a function of individual background illumination.
- (f) Terminal blocks screws shall be of the captive type secured by fasteners on the reverse side of the terminal block. Terminal block screws shall be a # 10 size.
- (g) Male spade terminal ends shall be furnished for each position on the terminal block angled at 45 degrees and perpendicular to the terminal block face.

**SPECIFICATION FOR**  
**TRAFFIC**  
**LED TRAFFIC SIGNAL MODULES**

**DESCRIPTION.** Furnish and install self-contained LED signal head modules to be used in place of the incandescent lamp, reflector, socket, gasket, and lens assembly of standard vehicle signal sections, as specified in the Contract Documents or as directed by the Engineer.

**MATERIALS.** Manufacturers of Red and Green 8-in. and 12-in. LED traffic signal modules are required to file a statement with the Maryland Energy Administration, certifying that each signal to be sold or offered for sale in Maryland is in compliance with the State's energy efficiency standard. Information on this requirement can be found at the Maryland Energy Administration's website.

The modules shall employ a lens assembly that presents an appearance that is similar to those found on standard incandescent signals.

LED signal heads, and all component parts shall meet the latest edition of the National Electrical Manufacturers Association (NEMA). In addition, LED signals shall meet the requirements set forth in the most recent, formally-adopted version of the specification titled "Vehicle Traffic Control Signal Heads - Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules," published by the Institute for Transportation Engineers (ITE).

- (a) The manufacturer must certify all signals meet or exceed all requirements of that specification over their entire 5-year warranty period.
- (b) Permanently identify serial numbers and model numbers, if available, on all removable components and hardware. The serial number and model number shall be etched, stamped, molded, or attached using metallic self-adhesive labels. The use of adhesive backed paper labels is not acceptable.

**CONSTRUCTION.** LED modules shall fit in standard, incandescent vehicle traffic signal housings without modifications or the need for special tools, and shall be complete with a one-piece, integral lens assembly that is tinted for the appropriate color.

**Design.** LED traffic signal modules shall have:

- (a) A printed circuit board inclusive of all of the LEDs and required circuit components.
- (b) Minimum 39- in. wire leads, minimum # 20 AWG, 600 volt, 105 C, with strain relief and spade terminals. Screw-type terminals shall not be allowed.
- (c) A rigid housing for protection in shipping, handling and installation:
- (d) A one piece neoprene gasket shall be used to seal out water and contaminants.

**Assembly Techniques.**

- (a) The LEDs within the modules shall be mounted and soldered to a printed circuit board.
- (b) LED signal modules shall be watertight when properly installed in traffic signal housings.
- (c) LED signal modules shall utilize the same mounting hardware used to secure a standard incandescent lens and gasket assembly, and shall only require a screwdriver or basic installation tools to complete the mounting.
- (d) LED signal module assemblies shall weigh less than 5 Lb.
- (e) LED signal modules may not protrude into the signal visor area more than two and three-quarters of an in. in depth.
- (f) LED signal modules shall be marked 'TOP' or have an up arrow to designate the proper orientation of the signal module in the traffic signal housing.
- (g) LED signal module housings shall utilize an integral metal layer in their design and construction.
- (h) LED signal modules shall utilize the latest technology in thermal management..

**Lenses.** Make lenses for ball type modules of ultraviolet stabilized polycarbonate, and incorporate facets that serve to enhance the optical efficiency of the LED traffic signal module. Individual *lens-lets* or external lens facets shall not be permitted.

- (a) The ball type signals shall incorporate a diffuser-type lens system that serves to collimate the light emitted by the LEDs. The lens and diffuser system shall focus the collimated light, to meet ITE intensity and distribution standards.
- (b) LED signals shall almost perfectly approximate the appearance of an incandescent traffic signal to the motorist.
  - (1) The face of the ball LED lamps shall appear to the motorist as uniform in illumination, and have a wide viewing angle that makes it suitable for installation on wide boulevards.
  - (2) The external lens surface for all vehicle signals shall be smooth, with no raised features, so as to minimize the collection of dirt, diesel smoke, and other particulate contaminants, and to facilitate periodic cleaning.
  - (3) The lens shall be keyed to the housing of the LED signal module to insure the proper orientation and to avoid possible rotation during any handling.
  - (4) Hard coat external lenses to prevent an accumulation of dust and dirt.
  - (5) For LED turn arrow signals, the LED arrow lens may be a replaceable part without the need to replace the complete LED arrow.

**Optical.** The light intensity, chromaticity, and distribution from eight and twelve-in. Red and Green, and eight-in. Yellow LED traffic signal modules shall meet all photometric values stated in the most recent, formally-adopted version of the specification titled "Vehicle Traffic Control Signal heads – Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules," published by the Institute for Transportation Engineers (ITE). Twelve-in. Yellow LED traffic signal modules shall meet the chromaticity requirements of the most recently-adopted ITE specification, with a minimum intensity of 1,500 candelas.

- (a) Red and Green LED signals shall be certified by the manufacturer to meet or exceed all requirements of that specification over their entire 5-year warranty period.
- (b) The light output from twelve-in. Yellow LED signals shall be the peak instantaneous intensity, measured at instant-on and at the highest intensity point.

**Design.**

- (a) The LEDs shall be connected in series-parallel strings.
  - (1) No more than 1 percent of the total luminosity of the entire signal module may be lost in the event of a single string failure.
  - (2) The failure of a single LED shall cause loss of light from only that LED.
  - (3) No loss of light output from the complete module assembly shall occur as a result of a single LED failure.
- (b) The control circuitry shall prevent the current flow through the LEDs in the off state to avoid any false indication as may be perceived by the human eye, during daylight and evening hours.
  - (1) The LED traffic signal module shall be operationally compatible with NEMA TS – 1 and NEMA TS – 2 conflict monitoring parameters.
  - (2) The intensity of the LED signal module shall not vary by more than 10percent over the allowable voltage range as specified in the electrical section below.

**Electrical.**

- (a) The Power factor shall be 0.90 or greater, at nominal rated voltage, at 25°C, after 60 minutes of operation.
- (b) Total harmonic distortion (THD) shall be less than 20 percent at rated voltage, at 25°C.
- (c) All LED traffic signal modules shall be in compliance with FCC noise regulations and must meet the FCC Title 47, SubPart B Section 15 regulation.
- (d) The LED junction technology used in all signal modules shall not exhibit degradation of more than 30percent of the modules' initial light intensity following accelerated life testing (operating at 85 degrees C and 85percent humidity, for 1000 hours). Under no circumstances shall AlGaAs technology be acceptable.
- (e) The LED signal modules shall be connected directly to line voltage, 120 Volts AC nominal, and shall be able to operate over the voltage range of 80 VAC to 135 VAC.

- (f) Red and Green LED traffic signal modules shall consume no more than a nominal 15 watts for either the 8" or 12" signal. Yellow signal modules shall consume no more than 24 watts.
- (g) Transient voltage suppression rated at 1500 watts for 1 millisecond and fusing with a maximum rating of 2 amps shall be provided to minimize the effect and repair cost of an extreme over voltage situation or other failure mode.
- (h) Low Voltage Turn OFF: There shall be no visible illumination from the LED signal module when the applied voltage is less than 50 VAC.
- (i) Turn-ON and Turn-OFF Time: A module shall reach 90percent of full illumination (turn-ON) within 75 msec of the application of the nominal operating voltage. The signal shall cease emitting visible illumination (turn-OFF) within 75 msec of the removal of the nominal operating voltage.

**Compatibility Testing:** The LED module manufacturer shall certify that their modules meet the Load Switch and Signal Conflict Monitor Compatibility testing requirements found in the most recent, formally-adopted version of the specification titled "Vehicle Traffic Control Signal heads - Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules," published by the Institute for Transportation Engineers (ITE).

**Electronic Failure Protection.** To assure compatibility with NEMA TS1/TS2 controllers for both conflict monitoring and Red Fail, all signal colors (Red, Yellow, and Green) once energized, must turn off prior to 50VAC, and if the signal fails it shall present a high impedance on the input side of the signal.

**Warranty.** Manufacturers shall provide a written with the following minimum provisions:

- (a) Modules shall be replaced, repaired or purchase value refunded if the module fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.
- (b) Modules which exhibit luminous intensities less than the minimum specified values within the first 60 months of the date of delivery shall be replaced, repaired or purchase value refunded.

**Miscellaneous.** The manufacturers part number, date code, and electrical characteristics of the LED signal module shall be visible on the rear of the assembly.

**MEASUREMENT AND PAYMENT.** Self-contained LED signal head modules will be measured and paid for at the contract unit price each. The payment will be full compensation for the LED module, hardware, assembly, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

## **SPECIFICATION FOR LED COUNTDOWN PEDESTRIAN SIGNALS**

**DESCRIPTION.** Furnish and install self-contained LED Pedestrian Countdown Signals, as specified in the Contract Documents or as directed by the Engineer.

**MATERIALS.** LED Pedestrian Signals and all component parts must meet the latest edition of the National Electrical Manufacturers Association (NEMA) Standards and Underwriters Laboratory (UL), as applicable. In addition, LED Pedestrian Countdown signals must meet the requirements set forth in the most recent, formally-adopted version of the specification titled "Pedestrian Traffic Control Signal Indications (PTCSI) - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules," published by the Institute for Transportation Engineers (ITE). All LED Pedestrian Countdown Signals must be certified by the manufacturer to meet or exceed all requirements of that specification over their entire 5-year warranty period. Serial numbers and model numbers, if available, must be permanently engraved on all removable components and hardware. The serial number and model number must be etched, stamped, molded, or attached using metallic self-adhesive labels. The use of adhesive backed paper labels is not acceptable.

**CONSTRUCTION.**

### **LED Countdown Signal Modules.**

- (a) LED countdown modules must fit into existing 16-inch traffic signal housings built to PTCSI standards without modification to the housing.
- (b) The LED countdown module must be a single, self-contained device, not requiring on-site assembly for installation into existing traffic signal housing.
- (c) The assembly of the LED countdown module must be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.
- (d) The signal module must be protected by a ¼ inch thick non-glare UV treated polycarbonate face lens.
- (e) The signal must have 2 individual sets of wires for electrical connections. One set for the hand/man section and another for the countdown section. Each set must be made of three secured, color coded (blue, red, white), 36 inches long, 600V, 16 AWG jacketed wires, rated for service at +105°C.

## Environmental

- (a) The LED countdown module must be rated for use in the ambient operating temperature range of  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) to  $+74^{\circ}\text{C}$  ( $+165^{\circ}\text{F}$ ).
- (b) Completely seal the LED countdown module against dust and moisture intrusion per the requirements of NEMA Standard 250 – 1991 sections 4.7.2.1 and 4.7.3.2 for type 4 enclosures to protect all internal components.

## Chromaticity

- (a) The measured chromaticity coordinates for the white walking Person and the Portland Orange Hand and Digits must conform to the chromaticity requirements of section 8.04 and figure 1 of the PTCSI standard.
- (b) The chromaticity measurements must remain unchanged over the input line voltage range of 80 VAC to 135 VAC.

## Display

- (a) The LED countdown signal module must consist of a double overlay message combining the symbols of a Hand and walking Person and two “7 segment” digits forming the time display.
- (b) Arrange the Pedestrian icon LEDs to form solid icon symbols. The shape of the symbols must conform to the standard symbols for pedestrian signals.
- (c) Distribute the LED's evenly in each Pedestrian icon. The distance between each LED shall be evenly spaced.
- (d) The Hand/Person symbols must be at least 10" high and 6.5" wide and must incorporate sufficient LED's to assure adequate luminous intensity.
- (e) The countdown digits must be at least 9" high and must be made of 2 rows of at least 144 LED's.
- (f) The Portland Orange LED's must be of the latest AlIn GaP technology and the white LED's of the latest In GaN technology.
- (g) Interconnect the individual LED light sources so that a catastrophic failure of a single LED will result in a total loss of not more than 3 LED's or 5% of the signal light output.

### Drive circuitry

- (a) The LED drive current shall be regulated to compensate for line voltage fluctuations over the range of 80VAC to 135 VAC. The luminous output shall not vary more than 1% over the voltage range and shall not be perceptible to the human eye.
- (b) The drive circuitry must include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in section 2.1.6, NEMA Standard TS-2, 1992.
- (c) The on-board circuitry must meet FCC title 47, Sub-Part B, Section 15 regulations concerning the emission of electronic noise.
- (d) The circuitry shall ensure compatibility and proper triggering and operation of load switches and conflict monitors in signal controllers currently in use by the procuring traffic authority.
- (e) The countdown signal shall not be activated by input signals under 80 VAC.
- (f) The “countdown” portion of the signal must have a high “off state” input impedance to ensure it does not prevent the conflict monitor from detecting an open load failure on the pedestrian signals. The input impedance of the countdown signal shall be such as to produce a load switch leakage voltage above 25 VAC to the conflict monitor for up to 4 units per channel.
- (g) The countdown signal drive circuitry must not suffer any damage when subjected to defective load switches providing a half wave signal output.
- (h) Typical power consumption of the countdown display must not exceed 5 watts with a power factor greater than 90%.

### Countdown Function.

- (a) The countdown module must be compatible with all types of traffic controllers.
- (b) The countdown timer module must have a micro-processor capable of recording it's own time when connected to a traffic controller.
- (c) When connected, the module must blank out the display during the initial cycle while it records the countdown time using the Walk & D/Walk signal indications.
- (d) The display of the number of remaining seconds shall begin only at the beginning of the pedestrian change interval.
  - (1) After the countdown displays “zero,” the display must remain dark until the beginning of the next countdown.
  - (2) The countdown pedestrian signal must display the number of seconds remaining until the termination of the pedestrian change interval.
  - (3) Countdown displays shall not be used during the walk interval, nor during the yellow change interval of a concurrent vehicular phase.
- (d) The countdown timer module shall continuously monitor the traffic controller for any changes to the pedestrian phase time and re-program itself automatically if needed.
- (e) The countdown module shall register the time for the walk and clearance intervals individually and shall begin counting down from the start of the clearance time or the sum of both interval times if selected.

- (f) If the walk interval is pre-empted (emergency vehicle), the countdown module shall skip the remaining walk time and begin the clearance interval countdown to reach 0 at the same time as the flashing hand becomes solid.
- (g) If the clearance interval is pre-empted (train), the countdown module shall skip the remaining clearance time and reach 0 at the same time as the flashing hand becomes solid.
- (h) In the cycle following a pre-emption call, the signal shall display the correct time and not be affected by the reduced previous cycle. The countdown must always reach 0 at the same time as the flashing hand becomes solid.
- (i) When the flashing hand becomes solid, the module will display "0" for one second and then blank-out.
- (j) The countdown timer must be capable of timing 2 consecutive complete pedestrian cycles outputted by the traffic controller (no steady hand signal between cycles).
- (k) The countdown module must have an internal conflict monitor preventing any possible conflicts between the Hand/Person signal indications and the time display. It shall be impossible for the countdown to display any time during a solid hand indication.
- (l) The countdown module shall have accessible dip-switches for the following user selectable options:
  - (1) Display 0 during stand-by.
  - (2) Turn on all LEDs for testing
  - (3) "Coordinated" mode, (displays clearance time only)
  - (4) Disable countdown display.
- (m) The LED module shall have a removable plug on the rear of the unit to allow for easy access to dip switches.
- (n) If the pedestrian change interval is interrupted or shortened as a part of a transition into a preemption sequence, the countdown pedestrian signal display must be discontinued and go dark immediately upon activation of the preemption transition.

**Housing.** Countdown Pedestrian Signals must be have a single piece cast aluminum case housing, a lens, and a single piece cast aluminum swing down door frame.

\*Using AMS-STD-595A, the signal head housing shall be yellow meeting Color Chip No. 13538. The signal head door and visor shall be optical flat (dull) black, Color No. 37038. Aluminum signal heads shall be painted using fusion bonded polyester coating method.

- (a) The maximum overall dimension of the signal shall be 18.5" W x 18.75" H x 9" D. (470 x 476 x 229 mm), including the visor and hinges. The distance between the mounting surfaces of the upper and the lower openings shall be 15.75" (400 mm).
- (b) The case shall be one piece corrosion resistant aluminum alloy die casting, complete with integrally cast top, bottom, sides and back.
  - (1) Four integrally cast hinge lug pairs, two at the top and two at the bottom of each case, shall be provided for operation of the swing down door.
  - (2) When properly mated to other pedestrian signal components and mounting hardware, the case shall provide a dustproof and weatherproof enclosure and shall provide for easy access to and replacement of all components.

(3) The case shall be mounted via upper and lower openings, suitable for either post top or bracket mounting. The openings must accommodate standard 1.5" (39 mm) pipe brackets. The bottom opening of the case must have a shurlock boss integrally molded into the case. The dimension of the shurlock boss shall be:

- (a) Outside diameter 2.625" (667 mm)
- (b) Inside diameter 1.969" (50 mm)
- (c) Number of teeth 72
- (d) Angle of teeth 90°
- (e) Depth of teeth 5/64" (2 mm) inch.

A shurlock boss of the same dimensions shall be an option for the top opening of the case. The radial angular grooves of the shurlock boss, when used with the shurlock fittings, shall provide positive positioning of the entire signal to eliminate rotation or misalignment of the signal.

- (c) The door frame shall be a one piece corrosion resistant aluminum alloy die casting, complete with two hinge lugs cast at the bottom and two latch slots cast at the top of each door.
  - (1) The door must be attached to the case by means of two Type 304 stainless steel spring pins.
  - (2) Two stainless steel hinged bolts with captive stainless steel wingnuts and washers must be attached to the case with the use of stainless steel spring pins.
  - (3) Latching or unlatching of the door must require no tools.

**Warranty.** Manufacturers shall provide a written warranty with the following minimum provisions:

- (a) LED countdown signal modules shall be replaced, repaired or purchase value refunded if the module fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.
- (b) LED countdown signal modules which exhibit luminous intensities less than the minimum specified values within the first 60 months of the date of delivery shall be replaced, repaired or purchase value refunded.

**Compatibility Testing:** The LED Pedestrian Countdown Signal manufacturer shall certify that their equipment meets the Load Switch and Signal Conflict Monitor Compatibility testing requirements found in the most recent, formally-adopted version of the specification titled "Pedestrian Traffic Control Signal Indications - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules," published by the Institute for Transportation Engineers (ITE).

**MEASUREMENT AND PAYMENT.** LED Pedestrian Countdown Pedestrian Signals will be measured and paid for at the contract unit price each. The payment will be full compensation for furnishing and installing the signals, LED modules, equipment specified, all mounting hardware, labor, warranty, and incidentals necessary to complete this work.

**SPECIFICATION FOR**  
**AUDIBLE/TACTILE PUSH BUTTONS AND PUSH BUTTONS SIGNS**

**DESCRIPTION.**

**ADD:** The following after the first paragraph.

Furnish and install self-contained audible/tactile pedestrian push button station and push button signs, as specified in the Contract Documents or as directed by the Engineer.

**MATERIALS.**

**ADD:** The following to the end of the list of materials.

**Audible/Tactile Pedestrian Push Button Station and Push Button Sign.** Provide audible/tactile pedestrian pushbutton station and signs and all component parts that meet the latest edition of the National Electrical Manufacturers Association (NEMA) Standards and Underwriters Laboratory (UL) standards, as applicable

If available, permanently engrave serial numbers and model numbers on all removable components and hardware. The serial number and model number shall be etched, stamped, molded, or attached using metallic self-adhesive labels. The use of adhesive backed paper labels is not acceptable.

**Audible/Tactile Pedestrian Model X Push Button Station with 3 LEDs and Push Button Sign.** Provide audible/tactile Model X pedestrian pushbutton station with 3 LEDs and signs and all component parts that meet the latest edition of the National Electrical Manufacturers Association (NEMA) Standards and Underwriters Laboratory (UL) standards, as applicable. LEDs shall flash to indicate when the beacon has been activated.

If available, permanently engrave serial numbers and model numbers on all removable components and hardware. The serial number and model number shall be etched, stamped, molded, or attached using metallic self-adhesive labels. The use of adhesive backed paper labels is not acceptable.

**CONSTRUCTION.**

**ADD:** The following after the last paragraph.

**Audible/Tactile Pedestrian Push Button Station and Push Button Sign.** Design audible/tactile pedestrian pushbutton station and signs to mount near or at the bottom of the pedestrian display mounting post. The pushbutton assembly for the audible signal may replace or supplement an existing pedestrian signal pushbutton.

Design audible/tactile pedestrian pushbutton station and signs as follows.

- (a) A single base unit at the traffic control cabinet shall be able to control 2 to 12 (maximum of 3 per phase) push button stations.
- (b) Only a single 2 conductor cable will be required from traffic controller cabinet per each pushbutton to operate all pushbutton features.
- (c) Each station will have a 2 in. button with a tactile raised directional arrow on the button.
  - (1) It shall be possible to change the arrow direction to one of four directions.
  - (2) Arrow/button shall vibrate during the walk period following a push of the button.
- (d) The push button station frame shall be cast aluminum with mounting holes for a 5 in. by 7.75 in. or larger pedestrian sign.

Provide audible/tactile pedestrian pushbutton station and signs that have the following features:

- (a) Locating tone
- (b) 5 walk sound choices that shall be field selectable.
- (c) 3 pedestrian clearance sound choices that shall be field selectable.
- (d) A direction of travel message shall be standard with extended push.
- (e) An information message shall be optional with extended push.

The audible sounds emitted by the audible/tactile pedestrian pushbutton station and signs shall have the following properties.

- (a) All audible sounds shall emanate from the push button station.
- (b) All audible sounds for all push button stations shall be synchronized.
- (c) Each audible feature shall have independently-adjustable minimum and maximum volume limits.
- (d) All sounds shall automatically adjust over a 60 dB range to compensate for ambient noise levels.
- (e) All volumes and optional features shall be settable using a handheld infrared device with password security. The infrared device shall be capable of updating/setting all

push button stations, or the intersection from a single pushbutton station (Global updating).

- (f) The ability to mute sounds at all crosswalks except activated crosswalks.

The system shall have user-selectable multiple language capability.

The system shall be able to play an emergency preemption message.

The system shall be able to self-test its buttons and to report any faults to the traffic controller.

**Warranty.** Audible/Tactile pushbutton station and signs shall be warranted by the manufacturer for a period of 24 months from the date of delivery.

**Compatibility Testing.** Audible/Tactile pushbutton station and signs manufacturers shall certify that their modules meet the load switch and signal conflict monitor compatibility testing requirements found in the most recent, formally-adopted version of the specification titled "Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules," published by the Institute for Transportation Engineers (ITE).

**Audible/Tactile Pedestrian Model X Push Button Station with 3 LEDs and Push Button Sign.** Design audible/tactile pedestrian Model X pushbutton station with 3 LEDs and signs to mount near or at the bottom of the pedestrian display mounting post. The pushbutton assembly for the audible signal may replace or supplement an existing pedestrian signal pushbutton.

Design audible/tactile pedestrian pushbutton station and signs as follows.

- (a) A single Model X base unit at the traffic control cabinet shall be able to control 2 Model X push button stations.
- (b) A single 8 conductor cable (No. 18 AWG) will be required from traffic controller cabinet per each pushbutton to operate all pushbutton features. Provide cable which is compatible with push button system.
- (c) Each station will have a 2 in. button with a tactile raised directional arrow on the button.
  - (1) It shall be possible to change the arrow direction to one of four directions.
- (d) The push button station frame shall be cast aluminum with mounting holes for a 5 in. by 7.75 in. or larger pedestrian sign.

Provide audible/tactile pedestrian pushbutton station and signs that have the following

features:

- (a) Locating tone
- (b) Sound choices that shall be field selectable.

The audible sounds emitted by the audible/tactile pedestrian pushbutton station and signs shall have the following properties.

- (a) All audible sounds shall emanate from the push button station.
- (b) All audible sounds for all push button stations shall be synchronized.
- (c) Each audible feature shall have independently-adjustable minimum and maximum volume limits.
- (d) All sounds shall automatically adjust over a 60 dB range to compensate for ambient noise levels.
- (e) The ability to mute sounds at all crosswalks except activated crosswalks.

The system shall have user-selectable multiple language capability.

**Warranty.** Audible/Tactile Model X pushbutton station and signs shall be warranted by the manufacturer for a period of 24 months from the date of delivery.

#### **MEASUREMENT AND PAYMENT.**

**ADD:** The following after the first paragraph.

Audible/Tactile Pedestrian Pushbutton Station and Signs will be measured and paid for at the contract unit price each. The payment will be full compensation for furnishing, programming, delivery to the specified signal shop for testing, pick up, and installing the push button stations, signs, all cables, labor, equipment, tools, and incidentals necessary to complete this work.

2 Wire APS Central Control unit will be measured and paid for at the contract unit price per each. The payment will be full compensation for furnishing, programming delivery to the specified signal shop for testing, pick up, and installing the audible/tactile pedestrian base unit and all cables, labor, equipment, tools, and incidentals necessary to complete this work.

Audible/Tactile Pedestrian Model X Pushbutton Station with 3 LEDs and Signs will be measured and paid for at the contract unit price each. The payment will be full compensation for furnishing, programming, delivery to the specified signal shop for testing, pick up, and installing the push button stations, signs, all cables, labor, equipment, tools, and incidentals necessary to complete this work.

8 Wire APS Central Control unit Model X will be measured and paid for at the contract unit price per each. The payment will be full compensation for furnishing, programming delivery to the specified signal shop for testing, pick up, and installing the audible/tactile pedestrian central control unit and all cables, labor, equipment, tools, and incidentals necessary to complete this work.

Electrical Cable – 8 Conductor No. 18 AWG for Model X APS Pushbutton will be measured and paid at the contract unit price per linear foot. The payment will be full compensation for all materials, labor, equipment, tools and incidentals necessary to complete the work.

**SPECIFICATION FOR**  
**GALVANIZED TRAFFIC SIGNAL PEDESTAL POLES AND**  
**TRANSFORMER BASES**

**DESCRIPTION.** Furnish and install galvanized traffic signal pedestal poles and transformer bases at locations specified in the Contract Document or as directed by the Engineer.

**MATERIALS.** Design shall meet 2001 edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals except as noted. All welding shall conform to American Welding Society (AWS) Structural Welding Code D1.1 - Steel, Tubular Structures.

Determine each pedestal pole's height by the total height of the pedestal pole including the transformer base.

- (a) 10 ft pole height consists of a 103 in. steel shaft with a steel base plate plus a 17 in. transformer base.
- (b) 14 ft pole height consists of a 151 in. steel shaft with a steel base plate plus a 17 in. transformer base.
- (c) 20 ft pole height consists of a 240 in. steel shaft with a steel base plate plus a 17 in. transformer base.

Each pedestal pole furnished shall consist of a design from a steel shaft with a steel base plate, transformer base and all miscellaneous hardware.

- (a) The pedestal pole shaft shall be fabricated of one length and shall have one longitudinal weld, parallel to the long axis of the pedestal pole shaft, with no transverse welds. The longitudinal weld shall be finished to form a smooth outside surface and the wall of the pedestal pole shaft shall be uniform in thickness including the welded area. The pedestal pole shaft shall be round or multi-sided (less than eight sides not acceptable) in cross section. 14 ft units shall be uniformly tapered from butt to tip with a 1 in. reduction in diameter for each 7 ft in length (0.14 in./ ft). 10 ft unit shall not be tapered.

- (1) 10 ft pedestal pole shaft shall be 4-1/2 in. outside diameter, Schedule 40 pipe, and conform to A 501.

- (2) All 14 ft pedestal poles shall be 7-1/2 in. outside diameter at the base and shall be made of 11 gauge (0.119 in.) thickness steel conforming to A 595, Grade A or equivalent.
- (3) All 20 ft pedestal poles shall be 7-1/2 in. outside diameter at the base and shall be made of 3 gauge (0.25 in.) thickness steel conforming to A 595, Grade A or equivalent
- (b) The base plate material shall meet the requirements of A 709, Grade 36. The base plate shall be secured to the lower end of the pedestal pole shaft by two continuous electric arc welds. The base plate shall telescope the pedestal pole shaft with one weld on the inside of the base plate at the end of the pedestal pole shaft. The remaining weld shall be located on the outside of the base plate at the top of the pedestal pole shaft. The weld connection shall develop the full strength of the adjacent pedestal pole shaft to resist bending action. All bases plate shall be fabricated with the holes for anchor bolts to the size and location dimensions as shown in MD-818.16 and 818.17.
- (c) 14 ft pedestal poles shall be furnished with entrance ways for cable as noted in the contract documents. These holes must be factory drilled and a straight tapped coupling, conforming to Underwriters Laboratory's UL-6 Specification, for 2 in. rigid conduits, must be installed for each hole. A nipple with a unitized hexagonal fitting and integral inside radius on one end must then be installed and fully seated on the interior side of the coupling. Location and installation of the coupling shall be as shown in MD-818.17.
- (d) All pedestal poles and hardware, except materials manufactured from stainless steel or cast aluminum, shall be hot dipped galvanized. The galvanized coating shall conform to the thickness, adherence and quality requirements of A 123 and A 153 for hardware. Threaded components shall be chased and cleaned after galvanizing. All internally threaded components shall be tapped oversize the minimum amount required to permit assembly on the coated externally threaded fastener. Internally threaded components shall be provided with a lubricant which shall be clean and dry to the touch. All poles are to be painted Federal Standard Number 595b-14066 or "HADCO GREEN".
- (e) Each pedestal pole shall be furnished with a removable domed cap, fabricated from cast aluminum, circumferentially attached to the side of the pole with three hex head type 304 stainless steel bolts (1/4 in. - 20 UNC).
- (f) Each pedestal pole shall have an identification plate mechanically attached 6 in. above the pedestal pole base plate and oriented so that the identification plate may be read from a ground observation position.

- (g) Recessed hub type, galvanized malleable iron plugs shall be inserted flush into all couplings.

### **Transformer Bases**

- (a) All transformer bases shall be approved by FHWA as meeting breakaway under NCHRP 350.
- (b) Each transformer base must be furnished with four hex head bolts, four hex head nuts and all associated hardware as shown on the appropriate detail for fastening the pedestal pole base plate to the top of the transformer base. All bolts shall conform to A 325 specifications and must be galvanized.

### **Anchor Bolts**

- (a) Each pedestal pole anchor bolt shall be made of steel conforming to M 314, Grade 55 S1
- (b) Anchor bolt threads shall be of cut thread design with a minimum 6 in. of threads at the top.
- (c) The template and anchor plates shall be as shown on MD801.01.
- (d) The diameter of the anchor bolt shall be stamped into the top of the threaded end of each anchor bolt.
- (e) Each anchor bolt shall be provided with two attached heavy hex nuts and two attached flat washers.
  - (1) Anchor bolt nuts shall conform to A 194, grade 2 or 2H, or A 563, D or DH.
  - (2) All nuts shall be tapped oversize the minimum amount required to permit assembly on the coated externally threaded fastener.
  - (3) Washers shall conform to F 436.
- (f) All nuts, washers, and the top 12 in. of all anchor bolts shall be hot dipped or mechanically galvanized. The galvanized coating shall conform to the thickness, adherence and quality requirements of A 123 or A 153 for hardware.

All high strength bolts (of a given length), nuts (of a given size) and washers (of a given diameter) shall be from the same manufacturing lot per each requisition of materials. The use of foreign made fasteners is prohibited.

### **CONSTRUCTION.**

Install the signal structure on a concrete foundation conforming to Section 801.

Breakway base support systems, when specified shall conform to Section 821.

Repair any finish on the signal structures and mounting hardware damaged during transportation and installation to match the original finish as approved by the Engineer at no additional cost to the City.

### **MEASUREMENT AND PAYMENT.**

Pedestal poles will be measured and paid for at the Contract unit price per each type of pole furnished and installed. The payment will be full compensation for furnishing and installing pedestal poles, breakaway bases and all materials, labor, equipment, tools and incidentals necessary to complete work.

Anchor bolts will not be measured, but the cost will be incidental to Concrete Foundations.

### **Tag Detail**

Mfg: _____ <sup>[1]</sup>	Contract #: _____ <sup>[2]</sup>
Pole Diameter: _____ <sup>[3]</sup>	Height: _____ <sup>[4]</sup> Gauge: _____ <sup>[5]</sup>
Anchor Bolts: _____ <sup>[6]</sup>	Bolt Circle: _____ <sup>[7]</sup>

### **Tag Reference**

[ 1 ] Name of the manufacturer of the pedestal pole.

[ 2 ] City Contract Number of the pedestal pole.

[ 3 ] Pole outside diameter at the base: 4-½ in. O.D. or 7-½ in. O.D.

[ 4 ] Pole height<sup>1</sup>: 10ft, 14ft, 20 ft

[ 5 ] Pole gauge: Schedule 40 or 11 GA

[ 6 ] Anchor bolt size: 1 in. Dia. x 40 in. Length

[ 7 ] Bolt circle diameter: 11 in. Dia.

<sup>1</sup>Pole height includes the height of the pedestal pole and transformer base. Typically, the transformer base is 17 in. in height which corresponds to 10 ft pole having a height of 103 in.; and a 14 ft having a height of 151 in

## **SPECIFICATION FOR COATING NEW GALVANIZED STRUCTURES**

**DESCRIPTION:** Coat new galvanized steel structures including exposed anchor bolts, flange bolts, nuts, and washers and as specified in the Contract Documents or as directed by the Engineer. Color will be as specified in the contract documents.

**MATERIALS:** Materials must conform to one of the systems described below. All coatings in the system must come from the same manufacturer. The Manufacturer must be on the "Approved List of Manufacturers" maintained by the Office of Materials and Technology, Metals, Coatings and Structural Materials Team.

Colors must conform to the following Federal Standards, or as specified in the Contract Documents.

Federal Standard Number 595b-14066 or "HADCO GREEN"

### **Paint System:**

**(A) Primer:** Shall be an Epoxy Polyamide meeting the requirements of Section 912.03.02 and must have a dry film thickness of 2 to 5 mils (50 to 125  $\mu\text{m}$ ).

**(B) Finish Coat:** Shall be an Aliphatic Polyurethane meeting the requirements of Section 912.04.02 and must have a dry film thickness of 2 to 4 mils (50 to 100  $\mu\text{m}$ ).

### **Fusion Bonded Polyester Powder System (all Signal & Lighting Structures):**

**Polyester Powder:** Polyester Powder must meet the requirements of Section 917

### **CONSTRUCTION:**

#### **Paint System**

**Surface Preparation** Galvanized steel will not be permitted to have been water or chromate quenched. The surface will be solvent cleaned per SSPC SP-1 using a non-residue solvent and a lint free cloth. The surface must also be Brush Off Blasted per SSPC SP-7 using Grit. Any damaged areas will be repaired according to ASTM A-780. If repair is made using an Organic Zinc Rich primer, the primer must conform to Section 912.02.03.

**Paint Application** Following the brush off blasting and prior to the application of the prime coat, store each item in an environment free of moisture and dust. Apply the primer within twelve (12) hours of brush off blasting and in accordance with the manufacture's recommendation.

Once the primer has properly cured, apply the finish coat in accordance with the manufacturer's recommendations.

The finished painted surface must be holiday free when tested with a low voltage holiday detector (minimum 30 volts). If holidays are detected, the coatings could be repaired with additional coatings or they may be stripped and repainted at the Contractor's expense.

#### **Fusion Bonded Polyester Powder System:**

**Surface Preparation:** Prepare the galvanized surface by solvent cleaning conforming to SSPC SP-1, followed by brush off blast cleaning conforming to SSPC SP-7 using grit. The blast profile shall be 2 to 3 mills as determined in conformance with D 4417, method C. When blast cleaning exposes bare steel, the bare steel must be spot primed with an Organic Zinc Rich Coating in conformance with A 780. The polyester powder must be applied within 24 hours of surface preparation.

**Application:** Fusion Bonded Polyester Powder shall be applied per manufacturer's recommendations.

**MEASUREMENT AND PAYMENT.** Coating of new structures will not be measured and paid for but will be incidental to the contract item. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the work.

**SPECIFICATION FOR  
PAINTING WEATHERED GALVANIZED STRUCTURES**

**DESCRIPTION.** Painting weathered galvanized steel structures including exposed anchor bolts, flange bolts, nuts, and washers as specified in the Contract Documents or as directed by the Engineer. Colors shall be as specified in the Contract Documents

**MATERIALS:** Materials shall conform to the requirements described below. All coatings in the system shall come from the same manufacturer. The Manufacturer shall be on the “Approved List of Manufacturers” maintained by the Office of Materials and Technology, Metals, Coatings and Structural Materials Team.

Organic Zinc Rich Primer	Section 912.02.03.
Polyamide Epoxy	Section 912.03.02.
Aliphatic Polyurethane	Section 912.04.02.

Colors shall conform to the following Federal Standards or as specified in the Contract Documents.

Green      Federal Standard Number 595b-14066 or “HADCO GREEN”

**CONSTRUCTION.**

**SURFACE PREPARATION :**

Inspect each structure prior to the application of any coating to ascertain the condition and thickness of the weathered zinc coating. This inspection shall determine the required surface preparation. Any or all of the following may exist on any given structure. The following are the possible surface conditions and their required surface preparation:

When a structure exhibits only bright galvanizing, thickness readings are required to insure that 2.5 mils minimum galvanizing remains. Surface preparation shall be SSPC SP-1 (Solvent Cleaning), followed by either SSPC SP-2 (Hand Tool Cleaning) or SSPC SP-7 (Brush Off Blast Cleaning). A minimum 1 mil surface profile shall be obtained.

When a structure exhibits a dull gray finish, take thickness readings in the dull gray areas to insure a minimum of 2.5 mils galvanizing remains. Surface preparation shall be SSPC SP-1 (Solvent Cleaning), followed by Power Washing using a pressure washer with the pressure not to exceed 1450 psi at the nozzle.

When a structure exhibits areas of white powder coating, surface preparation shall be SSPC SP-1 (Solvent Cleaning) followed by SSPC SP-2 (Hand Tool Cleaning). After the white powder has been removed, take thickness readings to insure a minimum 2.5 mils galvanizing remains. A minimum 1 mil surface profile must be obtained.

When a structure exhibits areas of red rust, take thickness readings to see if any galvanizing remains. Surface preparation shall be SSPC SP-1 (Solvent Cleaning), followed by SSPC SP-11 (Power Tool Cleaning to Near White). A minimum surface profile of 1 mil shall be obtained.

**PAINTING:** Paint the structures using the following materials.

Spot prime areas where there is less than 2.5 mils of galvanizing using Organic Zinc Primer at the manufacturers recommended thickness.

Apply a full coat of Polyamide Epoxy to the entire structure at the manufacturer's recommended thickness. There may be a recoat window for this material.

Apply a finish coat of Aliphatic Polyurethane to the entire structure at the manufacturers recommended thickness.

The finished painted surface must be holiday free when tested with a low voltage holiday detector (minimum 30 volts) similar to a K – D Bird Dog, using regular tap water. If holidays are detected, the coatings could be repaired with additional coatings or they may be stripped and repainted at the coaters' expense.

Apply all coatings in accordance with manufacturers recommendations.

Paint all structures within twenty-four (24) hours after surface preparation. If this time is exceeded, re-inspection will be necessary to insure no contamination of the cleaned surface has occurred prior to painting. Additional surface preparation may then be necessary.

**MEASUREMENT AND PAYMENT.** Painting of weathered galvanized structures will be measured and paid for at the Contract unit price per each structure. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the work.



When a structure exhibits areas of white powder coating, surface preparation shall be SSPC SP-1 (Solvent Cleaning) followed by SSPC SP-2 (Hand Tool Cleaning). After the white powder has been removed, take thickness readings to insure a minimum 2.5 mils galvanizing remains. A minimum 1 mil surface profile must be obtained.

When a structure exhibits areas of red rust, take thickness readings to see if any galvanizing remains. Surface preparation shall be SSPC SP-1 (Solvent Cleaning), followed by SSPC SP-11 (Power Tool Cleaning to Near White). A minimum surface profile of 1 mil shall be obtained.

**PAINTING:** Paint the structures using the following materials.

Spot prime areas where there is less than 2.5 mils of galvanizing using Organic Zinc Primer at the manufacturers recommended thickness.

Apply a full coat of Polyamide Epoxy to the entire structure at the manufacturer's recommended thickness. There may be a recoat window for this material.

Apply a finish coat of Aliphatic Polyurethane to the entire structure at the manufacturers recommended thickness.

The finished painted surface shall be holiday free when tested with a low voltage holiday detector (minimum 30 volts) similar to a K – D Bird Dog, using regular tap water. If holidays are detected, the coatings could be repaired with additional coatings or they may be stripped and repainted at the coaters' expense.

Apply all coatings in accordance with manufacturer's recommendations.

Paint all structures within twenty-four (24) hours after surface preparation. If this time is exceeded, re-inspection will be necessary to insure no contamination of the cleaned surface has occurred prior to painting. Additional surface preparation may then be necessary.

**MEASUREMENT AND PAYMENT.** Re-painting previously painted galvanized structures will be measured and paid for at the Contract unit price per each structure. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the work.

**SPECIFICATION FOR**  
**NON-INVASIVE, MAGNETO-INDUCTIVE MICROLOOP DETECTOR**

**DESCRIPTION.** Furnish and install non-invasive, magneto-inductive microloop vehicle detection sensors/probes. Install the sensors/probes as a set or assembly of three (3) per traveled lane.

**MATERIALS.** All materials and equipment furnished and installed must be new corrosion resistant, and approved by the Engineer. Manufacturer's certifications or certified copies of reports of tests shall be furnished as directed by the Engineer.

**CONSTRUCTION.**

**(a) Vehicle data collection requirements.**

- (1) Each non-invasive sensor shall have an inductance change that will allow an appropriately designed, matched inductive loop vehicle detector to detect all licensable vehicles that contain ferromagnetic material. The sensor will detect these vehicles when they are within a travel distance less than one half the height of the ferromagnetic material of the vehicle.
- (2) The non-invasive vehicle sensing assemblies shall consist of three sensors connected in series to a common lead in wire.
- (3) Connect each non-invasive, magneto-inductive vehicle sensing assembly to an appropriately designed, matched inductive loop vehicle detector.
- (4) Optimize traffic data collection or traffic flow parameter measurements across diverse roadway geometry by installing, triple non-invasive sensor assemblies.

**(b) Electrical and magnetic requirements**

- (1) The non-invasive sensor shall convert changes in the ambient magnetic field to changes in its inductance. An increase in the ambient magnetic field shall result in a decrease in the inductance of the non-invasive sensor, and the inductance change of the non-invasive sensor shall be directly proportional to the changes in the earth's magnetic field.

- (2) The nominal magnitude of the vertical magnetic field over which the non-invasive sensor shall function to specified requirements shall be 200 millioerstads to 800 millioerstads. The non-invasive sensor shall detect reliably and consistently changes in the ambient magnetic field of seven (7) millioerstad or greater when the earth's magnetic field is  $\geq 200$  millioerstad ( $H_{DC}=200$  mOe) and the peak-to-peak amplitude of the applied inductive current is 40 mAmp<sub>p-p</sub> ( $I_{AC} = 40$  mAmp<sub>p-p</sub>). This requirement defines the sensitivity to be  $\geq 2$  nanohenries/millioerstad at  $H_{DC}=200$  mOe and  $I_{AC} = 40$  mAmp<sub>p-p</sub>.
- (3) The sensor/probe inductance shall be between 50  $\mu$ H to 80  $\mu$ H. The nominal operating frequency of the probe shall be between 20 kHz and 60 kHz. The non-invasive sensor shall operate with drive currents of 2.5 mAmp<sub>p-p</sub> to 175 mAmp<sub>p-p</sub>. The specified electrical and operating requirements shall be maintained over temperatures ranging from -29.9 F to 162.5 F
- (c) **Sensor physical requirements.** The non-invasive sensor shall have a maximum outer diameter of 0.8125 in. and a maximum height of 2.25 in. and shall be suitably sealed for use in 100 percent humidity environments within a conduit. Equipment shall be included to secure the probes in the conduit, ensure proper orientation during installation, and maintain proper orientation through life of the device. The sensors shall have pull chords to facilitate installation and removal from the conduit. The probes shall be designed to be easily assembled on-site without the use of special tools and equipment. The sensors shall be serviceable from adjacent handholes. Installation of sensors shall not disturb roadway surface.
- (d) **Conduit installation requirements.**
- (1) For detection locations that shall require new conduit installation, the conduit shall be a 3 in. conduit consisting of schedule 80 PVC with an inner diameter of 2.9 in. and an outer diameter of 3.5 in. The conduit shall be installed at a nominal centerline depth of 20 in. from the road surface following the roadway crownline. The depth of the conduit centerline from the road surface shall be maintained between 18 and 22 in. over its entire length. The centerline of the conduit shall not deviate horizontally more than required by the application, however, any deviation in conduit alignment shall be less than 0.25 in. per foot. At least one end of the conduit shall terminate at a standard size handhole with a nominal 24 inch diameter and extend three in into the handhole, and the conduit shall have a grade to permit drainage.

(2) The non-invasive probes shall function in 3 in. conduits that have been previously installed at greater than the optimum operational depth stated above. Non-invasive probe installation and alignment for non-optimum pavement depths shall be performed as directed by the Engineer or described in the contract plans.

(e) **Probe lead-in cable.** The cable leading from each probe set or assembly to the controller shall be included with the probes.

**(f) Requirement of verification of proper installation**

(1) Provide a log of the boring depth measured every 2 ft in boring distance.

(2) Verify that the non-invasive sensor set or assembly and lead-in cable installation meets requirements by measuring the inductance of the non-invasive sensor assembly with a properly designed, matched vehicle detector. The installer shall verify that the installation meets requirements by measuring the DC resistance of the non-invasive sensor assembly with a properly calibrated ohm meter. The installer shall measure the change in inductance of the installed non-invasive sensor assembly using a properly designed, matched vehicle detector when a standard, midsize vehicle is driven directly over the sensor.

Provide a log of the measured inductance, DC resistance and the change in inductance for each installed non-invasive sensor assembly.

(3) The inductance shall be the sum of probe inductance, inductance of lead-in cable (16.5  $\mu$ H per 100 ft) and home-run cable (23  $\mu$ H per 100 ft) and shall be within  $\pm 20$  per cent of the calculated inductance. The measured DC resistance shall be the sum of 1.5 ohms per probe, 3.0 ohms per 100 ft of lead-in wire and 2.0 ohms per 100 ft of home-run cable and shall be within  $\pm 20\%$  of the calculated DC resistance. The measured change in inductance for a standard midsize vehicle shall be in the range from 120 nH to 1200 nH.

**MEASUREMENT OF PAYMENT.** Non-invasive Magneto Inductive Vehicle Detectors shall be measured and paid for at the contract unit price per each in the cable length specified. The payment will be full compensation for furnishing and installing one probe set, lead-in cable from the probe set to the field cabinet, probe carrier system, pull rope and all other incidentals. The payment shall be full compensation for all materials, labor, equipment and all other incidentals necessary to complete this work.

Conduit will be measured and paid for as specified in section 805.