



ARLINGTON

VIRGINIA

2017

Traffic Signal Specifications

This document contains the specifications for construction and maintenance of traffic signals within Arlington County. These specifications supplement related VDOT Road and Bridge Specifications.

Revision 2: 9/30/2017

List of Document Revisions

| Revision | Date | Description | Section(s) Impacted |
|----------|------------|---|--|
| 1 | 04/12/2017 | Added references to new standard mast arm pole foundation designs. | 13166 |
| 2 | 09/30/2017 | Amended several execution and pay items throughout existing sections. Minor modifications made to cabinet specification. Added new specifications for Electric Signal Service, Aerial Work, Vehicle Signals | 13160 13161 13164 13165 13166 13167 13169 13170 13172 13176 13177 13178 13179 13180 13181 13182 |

Content will appear highlighted in grey to mark changes that occur in the latest revision. Revisions from past updates will not appear shaded.

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Acronyms and Abbreviations for Traffic Signal Specifications

| | | | |
|--------|--|--------|---|
| °C | degrees Celsius | EN2 | Ethernet Adaptor |
| cm | centimeter | EVP | Emergency Vehicle Preemption |
| dB | decibel | FLIR | forward-looking infrared |
| Dia. | diameter | FOV | field of view |
| Hz | hertz | FS-ATS | Fail Safe Automatic Transfer Switch |
| ksi | kilopounds per square inch | HDPE | high-density polyethylene |
| lbs | pounds | ID | identification |
| mV | millivolt | IEEE | Institute of Electrical and Electronics Engineers |
| psi | pounds per square inch | IIM | Instructional and Informational Memorandum |
| SF | square feet | IMSA | International Municipal Signal Association |
| V | volt | IP | Internet protocol |
| VAC | volts alternating current | LCD | liquid crystal display |
| VDC | volts direct current | LED | light-emitting diode |
| W | watt | MUTCD | Manual on Uniform Traffic Control Devices for Streets and Highways |
| AASHTO | American Association of State Highway and Transportation Officials | NC | normally closed |
| AC | alternating current | NEC | National Electrical Code |
| ADA | Americans with Disabilities Act | NEMA | National Electrical Manufacturers Association |
| ANSI | American National Standards Institute | NESC | National Electrical Safety Code |
| APS | accessible pushbutton system | NFPA | National Fire Protection Association |
| ASTM | ASTM International | NO | normally open |
| AWG | American Wire Gauge | NTSC | National Television System Committee |
| AWS | American Welding Society | PBS | Pushbutton Station |
| BBS | battery backup system | PVC | polyvinyl chloride |
| BIU | Bus Interface Unit | ROW | right-of-way |
| CADD | computer-aided design and drafting | RS | Recommended Standard |
| CCTV | closed-circuit television | Rules | Rules for Overhead Electrical Line Construction of the Virginia Public Utilities Commission |
| CCU | Central Control Unit | S&B | Structures and Bridges |
| CCU2EN | Central Control Unit with Ethernet | TGIC | triglycidyl isocyanurate |
| County | Arlington County, VA | THD | total harmonic distortion |
| CSA | Canadian Standards Association | THHN | thermoplastic high-heat-resistant nylon-coated |
| DC | direct current | | |
| DTI | direct tension indicating | | |
| EIA | Electronic Industries Alliance | | |

TPS Trades Program Supervisor
UL Underwriters Laboratories
UPS uninterruptible power supply

USB universal serial bus
VDOT Virginia Department of
Transportation

Section 13160: Traffic Signal Installation

1 Description

This document contains the specifications for traffic signals and related electrical systems for projects in Arlington County, VA (County). These specifications include the installation of material, equipment, and work procedures that are described in the Arlington County Traffic Signal and Streetlight Standards. The specifications meet the minimum functional requirements that must be satisfied.

2 Reference Documents

- (a) All equipment and material shall conform to the standards of the following:
 - (1) Institute of Transportation Engineers
 - (2) International Municipal Signal Association (IMSA)
 - (3) 2016 Road and Bridge Specifications, Virginia Department of Transportation (VDOT)
 - (4) Virginia Professional Excavator's Manual, April 2014
 - (5) American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, latest edition
 - (6) VDOT Instructional and Informational Memorandum, Structure and Bridge Division (IIM-S&B)-90.2, VDOT Guidelines to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, 2013 with 2015 interims
 - (7) 2009 Manual on Uniform Traffic Control Devices (MUTCD), Federal Highway Administration
 - (8) American Welding Society (AWS) D1.1, Structural Welding Code
- (b) In addition to the requirements of the above specifications, the plans, standard details, special contract provisions, and all material and work shall conform to the requirements in the following:
 - (1) Virginia Supplement to the 2009 Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), Revision 1
 - (2) National Fire Protection Association (NFPA) 70, National Electrical Code (NEC)
 - (3) Institute of Electrical and Electronics Engineers (IEEE) C2-2017, National Electrical Safety Code (NESC)
 - (4) Rules for Overhead Electrical Line Construction of the Virginia Public Utilities Commission (Rules)

- (5) Standards of the American Society for Testing and Materials (ASTM) International (ASTM)
- (6) Standards of the American National Standards Institute (ANSI)
- (7) Arlington County Department of Environmental Services Construction Standards and Specifications
- (8) Arlington County Traffic Signal and Streetlight Standards and Specifications
- (9) National Electrical Manufacturers Association (NEMA), Standards Publication No. TS2-2003
- (10) ANSI/IEEE C.62.41, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits
- (11) Applicable local ordinances
- (12) Underwriters Laboratories (UL) Standards

Wherever reference is made in this document or in the special contract provisions to any of the rules and standards listed above, the reference shall be construed to be to the document that is in effect at the date of bidding.

3 Installer Certification

The Contractor(s) awarded under this contract shall have traffic signal technicians who have obtained an International IMSA Level II Traffic Signal Certification if they work on the project site and are in charge of any of the following:

- (a) All traffic signal-related electrical wiring terminations and splices, including but not limited to grounding, service entrances, and loops
- (b) Controller unit and cabinet assembly set-ups
- (c) Testing and review of all operational electrical equipment
- (d) Traffic signal assembly
- (e) Troubleshooting signals on flash or while working on controller cabinets
- (f) Cabinet preventive maintenance
- (g) Conduit installation (boring or trenching)
- (h) Pole foundation installation and pole setting
- (i) Junction box installation
- (j) Cable pulling and installation

4 Lead Worker / Supervisor

A Lead Worker / Foreman shall be assigned to each project. This individual is required to have at least 5 years of experience in traffic signal construction and installation and must

have an IMSA Level II Traffic Signal Technician Certification. The County must approve the Lead Worker / Foreman and his or her replacement(s) before work on the project begins.

5 Roadway Work and Permit

Unless stated otherwise, all roadway and sidewalk work shall be in accordance with the latest version of the Virginia Road and Bridge Standards and Specifications. If the VDOT and County specifications conflict, the Contractor shall notify the County Engineer. Generally, County specifications shall supersede VDOT specifications for County-maintained traffic signals and roadway work within the County right-of-way (ROW).

6 Equipment Salvage

- (a) All traffic signal equipment that is removed shall remain the property of the County. Such property is to be removed from the work site, tagged with date removed and location, and returned by the Contractor to the Arlington County Department of Environmental Services, 4300 29th Street S., Arlington, VA 22206. At the County Project Manager's discretion, the Contractor may be directed to dispose of the materials in lieu of salvage.
- (b) When signal pole and mast arm assemblies are removed, all components shall be marked as a set with permanent markings. The equipment shall be returned in the same condition as removed. Contact the Traffic Signal Supervisor to coordinate delivery. At the County Project Manager's discretion, the Contractor may be directed to dispose of the materials rather than deliver them to the County.

7 Existing Traffic Signals

- (a) When existing traffic signal installations are modified or completely rebuilt, the Contractor shall work around existing traffic signal equipment until the new or modified traffic signal system has been installed and put into operation.
- (b) Signal heads that are installed on span wire or poles for new installation and are not ready for actual electrical operation shall be bagged with black plastic or a suitable non-transparent material.
- (c) The Contractor shall maintain continuous operation of a minimum of two three-section (red, yellow, and green) traffic signal heads and pedestrian heads (if required) for each roadway approach. Special consideration shall be made to avoid the left-turn trap situation.

8 Intersection Power

The Contractor is responsible for coordinating power sources with Virginia Dominion Power to obtain power hook-up to the intersection and luminaires. The Contractor shall ensure coordination with Virginia Dominion Power from the early stages of construction to deliver the project on time.

9 Utilities

- (a) The utilities shown on the plans are based on records and surface field indications. All utility locations require field verification in cooperation with the affected utility companies and public agencies.
- (b) The Contractor shall follow the guidelines and procedures set forth in the Virginia Professional Excavator's Manual and is responsible for locating utility-related equipment such as gas and electric, and sewer laterals, valve boxes, and manholes and for ensuring that the equipment is properly protected and that signal equipment locations are adjusted accordingly with approval from the County Engineer.
- (c) Miss Utility does not locate private utility laterals. The Contractor is responsible for locating and marking private utilities in the work area or right-of-way prior to excavation. The Contractor is responsible for repairing any damage to private utilities that occurs as a result of construction at no additional cost to the owner.

10 Job Site Conditions

The Contractor shall maintain a safe and clean job site throughout construction. Upon project completion, the job site shall be neat and clean with all trash and dirt picked up and barricades removed. Landscaping shall be restored and sidewalks swept as needed. The job site shall be left in as good or better condition than it was before construction.

11 Maintenance of Traffic

All specifications assume that Maintenance of Traffic is incidental to the item descriptions provided unless a specific MOT plan is prepared for the signal work.

12 Required Submittals for Construction

Prior to beginning construction related activities, the Contractor shall provide submittals for all traffic signal and ITS equipment and poles. Use of a VDOT pre-approved material does not preclude the County's submittal requirement. However, if a product is on the VDOT approved materials list, this should be noted on the submittal to expedite review.

The submittals shall detail the products intended for installation and their conformance with VDOT and County specifications. Product compliance with required ASTM, ANSI, NEC, IMSA and other technical specifications shall be outlined on the submittals.

At a minimum, the Contractor is required to provide shop drawings and/or product submittals for:

- (a) Poles (including caps and bases)
 - (1) Mast Arms and Signal Poles (PE sealed drawings)
 - (2) Pedestal Poles
 - (3) Bollard Poles
 - (4) Streetlight Poles

(b) Equipment

- (1) Controller
- (2) Cabinet
- (3) Push buttons and CCU
- (4) Pre-emption Systems
- (5) Video Detection Systems
- (6) Vehicular and Pedestrian Signals and backplates
- (7) Mounting Equipment
- (8) Signs (regulatory, street name, guide signs, etc.)
- (9) LED blank outs
- (10) CCTV Camera System
- (11) Streetlight fixture
- (12) Battery Backup System (including auxiliary cabinet)
- (13) Meter Pedestal

(c) Cables

Section 13161: Junction Boxes

1 County Standards

The detail drawings in the Arlington County Traffic Signal Standards that are applicable to junction boxes are as follows:

- (a) 61-01 Small Junction Box (Non-Traffic Use)
- (b) 61-02 Traffic Rated Circular Junction Box
- (c) 61-03 Traffic Rated Circular Junction Box Frame and Cover
- (d) 61-04 Large Size Junction Box (Non-Traffic Use)

2 Materials

Composite junction boxes shall be Quazite Composite model number PC1212BA12 or equivalent with Cover PC1212CA00 or equivalent per County Standards. The cover shall be marked "Arlington County Transportation."

Traffic-rated junction boxes shall consist of a 24-inch steel frame and cover set on top of a 24-inch-diameter pre-cast structure per standards.

3 Execution

Execution shall consist of providing the specified box, any required excavation to install the box, installing required conduits into the box, and patching conduit entrance holes per County Standards.

- (a) All conduits entering a junction box shall enter the box tangent to the box wall at the entry point.
- (b) Conduit entry holes shall be patched such that debris and water cannot enter the structure.
- (c) Conduits shall have bell ends installed in junction boxes.
- (d) Conduits shall enter the sides of the structure at the depth of the conduit run and extend a minimum of 2 inches and a maximum of 3 inches into the structure.
- (e) All junction boxes shall be set on washed gravel with a minimum of depth of 12 inches.
- (f) The top of the junction box shall be installed flush with the grade unless otherwise specified.
- (g) All metal junction box lids shall be painted black after final installation.
- (h) All connections to grounding rods shall be accomplished by mechanical splice using grounding acorn clamps.

- (i) A 5/8-inch by 8-foot copper-clad grounding rod shall be installed in each junction box.
- (j) Small junction boxes shall consist of a 12-inch by 12-inch (internal diameter) Quazite box with Quazite Composite PG Series 12-7/8-inch by 12-7/8-inch box with cover per County Standards.
- (k) Traffic-rated junction boxes shall consist of 24-inch-diameter frames and covers set on top of 24-inch-diameter pre-cast structures per County standards.
- (l) Conductor cables shall be installed with their slack length coiled in junction boxes. The coiled length shall be sufficient to allow cables to extend at least 4 feet above the junction box.
- (m) The Contractor shall drill out an area to insert conduits to enter existing junction boxes as directed by the Engineer or authorized representative. The entry point for the conduits shall be 18 to 24 inches below finished grade.
- (n) Remove Junction Box shall include removing the junction box, capping or removing conduits, backfill and compaction, and final restoration.
- (o) Adjusting Junction Box to grade shall include excavating around the existing box, installing any needed riser sections, re-setting the existing box, re-working conduits, and compacting around the box as needed.

4 Measurement and Payment

- (a) **Furnish Junction Box** shall be measured and paid for per each. The price for a junction box shall include the box, the frame and cover, and any hardware required for installation.
- (b) **Furnish Junction Box Lid** shall be measured and paid for on a per-unit basis and shall include all bolts and necessary hardware required for installation. For circular junction boxes, cost of the lid shall include both frame and cover. For larger, double-door junction boxes, the cost of the lid shall include both halves.
- (c) **Install Junction Box** shall be measured and paid for per each. All materials associated with junction box installation, including frame and cover, grounding rod, parging, gravel base, and ground wire, shall be incidental. Restoration of damaged grass, pavers, concrete, asphalt, or other areas shall be incidental.
- (d) **Enter Existing Junction Box** shall be measured and paid for per each. Payment for entry of junction boxes shall be the same regardless of the type of junction box entered or the number of conduits connected. Restoration of damaged grass, pavers, concrete, asphalt, or other areas shall be incidental.
- (e) **Remove Junction Box** shall be measured and paid for per each. The disposal of the box shall be incidental to the item. Restoration of damaged grass, pavers, concrete, asphalt, or other areas shall be incidental.

- (f) ***Adjust Existing Junction Box to Grade*** shall be measured and paid for per each. Payment for adjustment of junction boxes shall be the same regardless of the type of junction box adjusted or the number of connected. Restoration of damaged grass, pavers, concrete, asphalt, or other areas shall be incidental.

Section 13162: Non-Ornamental Signal Mast Arm Poles

1 County Standards

The detail drawings in the Arlington County Traffic Signal Standards that are applicable to non-ornamental mast arm poles are as follows:

- (a) 62-01 Non-Ornamental Pole Design Criteria
- (b) 62-02 Non-Ornamental Pole Data (1 of 3)
- (c) 62-03 Non-Ornamental Pole Data (2 of 3)
- (d) 62-04 Non-Ornamental Pole Data (3 of 3)
- (e) 62-05 Non-Ornamental Pole
- (f) 62-06 Non-Ornamental Pole Details
- (g) 62-07 Non-Ornamental Mast Arm Connections (1 of 2)
- (h) 62-08 Non-Ornamental Mast Arm Connections (1 of 2)
- (i) 62-09 Non-Ornamental Pole Details
- (j) 62-10 Non-Ornamental Pole Anchor Bolts

2 General

This section describes minimum acceptable design and installation standards for poles and arms for traffic signals.

The Contractor shall provide Arlington County a written warranty against any defects in materials and workmanship for 1 year from the date of delivery to Arlington County.

For warranty repairs, all costs of labor, parts, and transportation to and from the site shall be borne by the Contractor.

3 Design

The design shall be in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 6th Edition 2013 with 2015 Interims and VDOT IIM-S&B-90.2.

All welding shall be in accordance with Sections 1 through 8 of AWS D1.1, Structural Welding Code. Tackers and welders shall be qualified in accordance with AWS D1.1.

4 Design Loading Requirements

- (a) Structure components and their connections shall be designed to resist the worst-case loading, upon evaluation of all applicable cases acting separately.
- (b) Design attachment loading
 - (1) Attachment loading data are shown in Table 3-1.

Table 62-1: Design Attachment Loading (Dead Loads)

| Attachment | Surface Area (SF) | Dead Load (lbs) |
|--|--------------------------|------------------------|
| Aluminum three-section head | 6 | 63 |
| Aluminum four-section head | 8 | 84 |
| 8-foot x 2-foot street name sign | 16 | 48 |
| 10-foot x 2-foot street name sign | 20 | 60 |
| 30-inch x 36-inch regulatory sign | 7.5 | 22.5 |
| CCTV camera | 1 | 22 |
| Video detection camera | 1 | 22 |
| Opticom device | 1 | 22 |
| Luminaire | 2 | 40 |
| SF = square feet; lbs = pounds; CCTV = closed-circuit television | | |

- (2) 0- to 40-foot mast arm lengths
 - (i) Three aluminum three-section heads spaced every 10 feet
 - (ii) One aluminum four-section head at the end of the arm (1 foot in from the end)
 - (iii) One 8-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Two 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One closed-circuit television (CCTV) camera halfway on the arm
 - (vi) One video detection camera over the outside lane
 - (vii) One Opticom device located 2 feet in from the end of the arm
- (3) 42- to 50-foot mast arm lengths
 - (i) Four aluminum three-section heads spaced every 10 feet
 - (ii) One aluminum four-section head at the end of the arm (1 foot in from the end)
 - (iii) One 8-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Three 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) One video detection camera over the outside lane

- (vii) One Opticom device located 2 feet in from the end of the arm
- (4) 52- to 60-foot mast arm lengths:
 - (i) Four aluminum three-section heads spaced every 10 feet
 - (ii) Two aluminum four-section head at the end of the arm (1 foot in from the end)
 - (iii) One 8-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Four 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) Two video detection cameras (over the outside lane, and over the middle of the remaining length)
 - (vii) One Opticom device located 2 feet in from the end of the arm
- (5) 62- to 66-foot mast arm lengths
 - (i) Five aluminum three-section heads spaced every 10 feet
 - (ii) Two aluminum four-section head at the end of the arm (1 foot in from the end)
 - (iii) One 10-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Five 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) Two video detection cameras (over the outside lane and over the middle of the remaining length)
 - (vii) One Opticom device located 2 feet in from the end of the arm
- (6) All poles shall also be designed for one 12-foot luminaire arm and one luminaire at the end of the luminaire arm. This allows longer luminaire arms to be installed in the future.
- (c) Wind loading

The entire assembly shall be designed to meet the wind loading requirements of VDOT IIM-S&B-90.2.
- (d) Fatigue loading

The entire assembly shall be designed to meet the fatigue loading requirements of VDOT IIM-S&B-90.2.
- (e) Special designs

Mast arm signal pole systems with a larger loading than specified above require a special design. Special designs shall be submitted to the County with sealed shop drawings and a letter from a Professional Engineer in the Commonwealth of Virginia certifying that the design meets the requirements of this specification.

Design shall include mast arm(s), luminaire arm, pole, baseplate, and anchor bolt analysis. Maximum arm and pole loads, stresses, and combined stress ratios shall be provided for each group load, as well as maximum pole dead load rotation.

For anchor bolt forces, pole forces shall be positioned in such a manner to maximize the force on any individual bolt regardless of the actual bolt orientation with the pole. The design of anchor bolts shall result in a ductile steel failure prior to any sudden brittle failure of the concrete.

Provide to the County, shop drawings detailing the poles as designed. Shop drawings shall contain all component drawings necessary to fabricate the structure. Drawings shall at a minimum specify the pole height, arm length(s), pole and arm diameters at the base and tip, splice locations, bolt circle diameter, bolt diameters, and detailed drawings showing the handhole cover assemblies. The drawings shall also show the width, depth, length, and thickness of all material and list pertinent ASTM specification designations together with the tensile strength of metallic members.

5 Materials

- (a) The materials used for construction shall meet the requirements listed in Table 3-2.

Table 62-2: Material Yields for Construction Components

| Component | ASTM Designation | Minimum Yield (ksi) |
|---|------------------------|---------------------|
| Pole shaft | A595 or A572 | 55 |
| Pole base | A36 | 36 |
| Galvanizing structure | A123 | — |
| Galvanizing hardware | A153 | — |
| Arm shaft | A595 or A572 | 55 |
| Arm connection | A36 | 36 |
| Arm connection bolts | F3125 GALVD. To A153 | — |
| DTI washers | ASTM F959 | — |
| Luminaire arm shaft | Per manufacturer | 35 |
| Luminaire arm casting | A27GR.65-35 | 35 |
| Luminaire arm connection bolts | SAE GR.5 or ASTM F3125 | — |
| Plate and channel | A36 | 36 |
| Anchor bolts | F1554 | 55 |
| ksi = kilopounds per square inch; DTI = direct tension indicating | | |

- (b) The manufacturer shall provide mill certifications for steel materials.
- (c) All poles, arms, transformer bases, and hardware shall be galvanized with powder coating or painted as specified on the plans or by the Engineer prior to installation.
- (d) Non-ornamental poles shall have a rust-resistant coating applied to the inside of the pole. The color of the outside of the pole will be specified at time of order. All poles, arms, ornamental bases, and hardware shall use one of the following coating systems:
 - (1) Option 1
 - (i) Primer = DuPont 25P Primer
 - (ii) Top Coat = DuPont 333 Imron
 - (2) Option 2
 - (i) Triglycidyl isocyanurate (TGIC) polyester powder at a minimum thickness of 2.0 mils

6 Pole Shafts

- (a) There are four size categories of single-arm mast arm poles:
 - (1) 20 to 40 feet
 - (2) 42 to 48 feet
 - (3) 50 to 60 feet
 - (4) 62 to 66 feet

To achieve interchangeability between poles and foundations, all of the poles in a size category shall have the same base plate size and bolt pattern.

- (b) There are four size categories of dual-arm mast arm poles:
 - (1) 20 to 40 feet
 - (2) 42 to 48 feet
 - (3) 50 to 60 feet
 - (4) 62 to 66 feet

The lengths listed are the longest arm. To achieve interchangeability between poles and foundations, all of the poles in a size category shall have the same base plate size and bolt pattern.

- (c) Mast arm poles shall be 30 feet tall. The mast arm connection shall be located 20 feet above the base of the pole. The luminaire arm connection shall be located 29 feet and 6 inches above the base of the pole.

Truncated pole shafts (poles without extra height for luminaires) shall be 2 feet taller than the top of the connection plate. The design of the pole should assume conditions for a pole with luminaire arm.

- (d) Mast arm poles shall be round. Multi-sided pole shafts are unacceptable. The shaft shall be one piece and contain no circumferential weld butt splices. The shaft shall have a constant linear taper of 0.14 inch per foot. The minimum thickness of steel shall be 7 gauge.
- (e) Pole diameters at the connection to the base plate shall not exceed the diameters listed in Table 3-3.

Table 62-3: Pole Design Shaft Diameter

| Single-Mast Arm Poles | | Dual-Mast Arm Poles | |
|--|----------------|---------------------------|----------------|
| Arm Length (ft) | Max Dia. (in.) | Arm Length (largest) (ft) | Max Dia. (in.) |
| <40 | 18 | <50 | 20 |
| 40-48 | 20 | 50+ | 24 |
| 50+ | 24 | — | — |
| ft = feet; in. = inches; dia. = diameter | | | |

- (f) Identification tag

Provide an identification tag affixed to the pole with the following information:

- (1) Arlington County, VA
- (2) Manufacturer
- (3) Date of manufacture (MM/YY)
- (4) Pole height and gage
- (5) Arm length and gage
- (6) Anchor bolt diameter and length
- (7) Bolt circle diameter (on center of bolts)
- (8) Serial number

The tag shall be attached between 4 feet and 5 feet above the base of the pole.

- (g) Handholes

- (1) An access hole and J-hook shall be provided on the opposite side of the pole shaft from the mast arm at the same elevation as the center of the mast arm. The access hole at the mast arm height shall have an outside dimension of 4 inches by 6 inches exclusive of reinforcement. The handhole cover shall be attached to the inside of the pole with a chain to prevent dropping the handhole cover.

- (2) A second access hole shall be provided 2 feet above the pole base to the bottom of the access hole. The lower access hole shall be provided on the opposite side from the attachment of the longest mast arm. The lower access hole shall have an outside dimension of 6 inches by 8 inches exclusive of reinforcement.
 - (3) Provide a grounding L-clip welded directly opposite the access hole on the inside wall of the pole.
 - (4) All handholes shall have a neoprene rubber gasket that is permanently secured to the handhole frame to ensure weather-tight protection. Handholes shall be provided with a bolted-on galvanized steel cover painted to match the pole. The handhole cover shall be removable from the frame.
- (h) Connection plate
- The mast arm connection plate shall be located 20 feet above the base of the pole. The connection plate shall have an upward angle 3 degrees from the horizontal plane. See attached drawings.
- (i) Pole top
- Each pole shall be provided with an end cap secured in place with set screws.
- (j) Luminaire arm
- (1) Poles shall be supplied with a luminaire arm. The luminaire arm shall be a King Luminaire model KA120-S or equivalent. See attached drawings.
 - (2) The luminaire arm connection shall be located 29 feet and 6 inches above the base of the pole. The arm shall extend 6 feet from the pole shaft.

7 Mast Arms

- (a) There are four size categories of mast arms:
 - (1) 20 to 40 feet
 - (2) 42 to 48 feet
 - (3) 50 to 60 feet
 - (4) 62 to 66 feet
- (b) To achieve interchangeability between arms and poles, all of the arms in a size category shall have the same connection plate size and bolt pattern.
- (c) Mast arms shall be round. Multi-sided and fluted mast arms are unacceptable. Mast arms shall have a constant linear taper of 0.14 inch per foot. The minimum thickness of steel shall be 7 gauge.
- (d) Mast arms up to 50 feet in length shall be manufactured and shipped in one piece. Mast arms 50 feet and longer shall be manufactured and shipped in two pieces with

no piece having a length greater than 40 feet. Circumferential welded tube butt splices and laminated tubes are not permitted.

- (e) Wire entrance holes 1-3/8 inches in diameter shall be drilled into the bottom of the arm every 11 feet starting at a point approximately 9 inches from the free end of the arm. Rubber grommets shall be installed in all wire entrance holes.

8 Anchor Bolts

- (a) A minimum of six fully galvanized anchor bolts shall be supplied for all mast arm poles. There shall be two steel templates provided per pole. All templates shall be fully galvanized.
- (b) Provide galvanized nuts compatible with the anchor bolts as needed to complete the installation. Nut covers shall be provided for all nuts.
- (c) Furnish two flat washers with each bolt/nut/washer assembly. Furnish galvanized direct tension indicating (DTI) washers. Use the size, number, type, and configuration of hardened flat washers the DTI manufacturer recommends for the anchor bolt diameter.
- (d) The following notes shall be included on all plans and/or shop drawings in reference to anchor bolts:
 - (1) Pretensioning of all anchor bolts is required and shall be accomplished with the use of DTI washers. Nuts shall be tightened until proper pretensioning is indicated by the DTI washer.
 - (2) The maximum clearance between the bottom of the leveling nuts and the top of the concrete is critical and shall not exceed the amount specified on the drawing.

9 High-Strength Bolts

- (a) Provide galvanized high-strength bolts for connections. Provide galvanized nuts compatible with the bolts as needed to complete the installation.
- (b) Furnish two flat washers with each bolt/nut/washer assembly. Furnish galvanized DTI washers. Use the size, number, type, and configuration of hardened flat washers the DTI manufacturer recommends for the bolt diameter.

10 Execution

- (a) Installation of mast arm poles shall include transporting the poles from the Arlington County Trades Center or other designated location to the job site, placing the poles on the proper foundations, and installing luminaire arms if necessary. Once placed, the Contractor must properly clean all poles and remove all labels prior to acceptance.
 - (1) Steel poles shall be placed and securely mounted on concrete foundations.

- (2) Strain poles and mast arm poles shall have a 3% rake or as specified by the Engineer or the authorized representative such that the pole is vertical under dead loads.
 - (3) All pole accessories including scrolls, nuts, nut covers, handhole covers, mast arm end caps, and pole caps shall be in place prior to acceptance.
 - (4) Installation shall include bolting the mast arm(s) to the pole. Any traffic control required for installation shall be incidental to the installation of the mast arm.
 - (5) Pretensioning of all connection and anchor bolts is required and shall be accomplished with the use of DTI washers. Nuts shall be tightened until proper pretensioning is indicated by the DTI washer according to the instructions detailed by the DTI washer manufacturer.
 - (6) Field welding is not permissible without written approval by the Engineer.
 - (7) The use of grout under base plates is not permitted.
 - (8) Install traffic signal heads and signs within 5 days after the mast arm is installed.
- (b) Removal of strain pole shall include the removal of the pole, overhead span wire, and any equipment on the pole or span. The Contractor shall check with the County representative on whether to salvage and return the pole. The foundation of the pole shall be removed to a minimum of 2 feet below grade or as required for installation of the new pole.
 - (c) Removal of mast arm pole shall include removal of the pole including the mast arm from the site. The Contractor shall check with the County representative on whether to store it or dispose of it. The foundation of the pole shall be removed as per County specifications.
 - (d) Removal of wood poles shall include removal of the wood pole from the site and disposal of the pole by the Contractor. The hole remaining shall be backfilled with select material and compacted to a density of 95%. The area disturbed by removal of the pole shall be patched with cold mix asphalt.
 - (e) Removal of down guy shall include the removal and disposal of the guy strand, guy guard, guy anchor rod, and associated hardware from the pole. The Contractor shall dispose of these materials at its own expense.

11 Measurement and Payment

- (a) ***Furnish Traffic Signal Pole*** shall be measured and paid for at the contract unit price per each for each size. This shall include mast arms, flanges plates, anchor plates, bolts, transformer bases, painting, welding, labor, and all other associated equipment and hardware required for installation.

- (b) **Furnish Luminaire Arm** shall be measured and paid for at the contract unit price per each. This shall include mounting, LED lamp, photocell, and all other associated equipment and hardware required for installation.
- (c) **Install Signal Pole & Mast Arm** shall be measured and paid for on a per-unit basis. When not included as a separate line item, but where called for on the plans, installation of luminaire arms shall be included in the installation cost of the signal pole.
- (d) **Remove Signal Pole & Mast Arm** shall be measured and paid for on a per-unit basis.
- (e) **Remove Signal Strain Pole** shall be measured and paid for on a per-unit basis.

Section 13163: Round Fluted Ornamental Mast Arm Poles

1 County Standards

- (a) 63-01 Ornamental Pole Design Criteria
- (b) 63-02 Ornamental Pole Data (1 of 3)
- (c) 63-03 Ornamental Pole Data (2 of 3)
- (d) 63-04 Ornamental Pole Data (3 of 3)
- (e) 63-05 Ornamental Pole
- (f) 63-06 Ornamental Mast Arm Connections (1 of 2)
- (g) 63-07 Ornamental Mast Arm Connections (1 of 2)
- (h) 63-08 Ornamental Pole Details
- (i) 63-09 Ornamental Pole Anchor Bolts

2 General

- (a) This section describes minimum acceptable design and installation standards for poles and arms for traffic signals.
- (b) The Contractor shall provide the County with a written warranty against any defects in materials and workmanship for a period of 1 year from the time of delivery to the County.
- (c) For warranty repairs, all costs of labor, parts, and transportation to and from the Contractor shall be borne by the Contractor.

3 Design

- (a) The design shall be in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 6th Edition 2013 with 2015 Interims and VDOT IIM-S&B-90.2.
- (b) All welding shall be in accordance with Sections 1 through 8 of AWS D1.1 Structural Welding Code. Tackers and welders shall be qualified in accordance with AWS D1.1.

4 Design Loading Requirements

- (a) Structure components and their connections shall be designed to resist the worst-case loading, upon evaluation of all applicable cases acting separately.
- (b) Design attachment loading
 - (1) Attachment loading requirements are summarized in Table 4-1.

Table 63-1: Attachment Design Loading (Dead Load)

| Attachment | Surface Area (SF) | Dead Load (lbs) |
|--|-------------------|-----------------|
| Aluminum three-section head | 6 | 63 |
| Aluminum four-section head | 8 | 84 |
| 8-foot by 2-foot street name sign | 16 | 48 |
| 10-foot by 2-foot street name sign | 20 | 60 |
| 30-inch by 36-inch regulatory sign | 7.5 | 22.5 |
| CCTV camera | 1 | 22 |
| Video detection camera | 1 | 22 |
| Opticom device | 1 | 22 |
| Luminaire | 2 | 40 |
| SF = square feet; lbs = pounds; CCTV = closed-circuit television | | |

- (2) 0-foot to 40-foot mast arm lengths:
 - (i) Three aluminum three-section heads spaced every 10 feet
 - (ii) One aluminum four-section head at the end of the arm (1 foot in from the end)
 - (iii) One 8-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Two 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) One video detection camera over the outside lane
 - (vii) One Opticom device located 2 feet in from the end of the arm
- (3) 42-foot to 50-foot mast arm lengths:
 - (i) Four aluminum three-section heads spaced every 10 feet
 - (ii) One aluminum four-section head at the end of the arm (1 foot in from the end)
 - (iii) One 8-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Three 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) One video detection camera over the outside lane
 - (vii) One Opticom device located 2 feet in from the end of the arm

- (4) 52-foot to 60-foot mast arm lengths:
 - (i) Four aluminum three-section heads spaced every 10 feet
 - (ii) Two aluminum four-section heads at the end of the arm (1 foot in from the end)
 - (iii) One 8-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Four 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) Two video detection cameras (over the outside lane, and over the middle of the remaining length)
 - (vii) One Opticom device located 2 feet in from the end of the arm
- (5) 62-foot to 66-foot mast arm lengths:
 - (i) Five aluminum three-section heads spaced every 10 feet
 - (ii) Two aluminum four-section heads at the end of the arm (1 foot in from the end)
 - (iii) One 10-foot by 2-foot street name sign mounted between the inside two signals
 - (iv) Five 30-inch by 36-inch regulatory signs (next to the last two signal heads)
 - (v) One CCTV camera halfway on the arm
 - (vi) Two video detection cameras (over the outside lane, and over the middle of the remaining length)
 - (vii) One Opticom device located 2 feet in from the end of the arm
- (6) All poles shall also be designed for one 12-foot luminaire arm and one luminaire at the end of the luminaire arm. This allows longer luminaire arms to be installed in the future.

(c) Wind loading

The entire assembly shall be designed to meet the wind loading requirements of VDOT IIM-S&B-90.2.

(d) Fatigue loading

The entire assembly shall be designed to meet the fatigue loading requirements of VDOT IIM-S&B-90.2.

(e) Special designs

- (1) Mast arm signal pole systems with a larger loading than specified above require a special design. Special designs shall be submitted to the County with sealed

shop drawings and a letter from a Professional Engineer registered in the Commonwealth of Virginia certifying that the design meets the requirements of this specification.

- (2) Design shall include mast arm(s), luminaire arm, pole, baseplate, and anchor bolt analysis. Maximum arm and pole loads, stresses, and combined stress ratios shall be provided for each group load, as well as maximum pole dead load rotation.
- (3) For anchor bolt forces, pole forces shall be positioned in such a manner to maximize the force on any individual bolt regardless of the actual bolt orientation with the pole. The design of anchor bolts shall result in a ductile steel failure prior to any sudden brittle failure of the concrete.
- (4) Provide to the County shop drawings detailing the poles as designed. Shop drawings shall contain all component drawings necessary to fabricate the structure. Drawings shall at a minimum specify the pole height, arm length(s), pole and arm diameters at the base and tip, splice locations, bolt circle diameter, bolt diameters, and detailed drawings showing the handhole cover assemblies. The drawings shall also show the width, depth, length, and thickness of all material and list pertinent ASTM specification designations together with the tensile strength of metallic members.

5 Materials

- (a) The materials used for construction shall meet the requirements in Table 4-2.

Table 63-2: Material Yields for Construction Components

| Component | ASTM Designation | Minimum Yield (ksi) |
|--------------------------------|------------------------|---------------------|
| Pole shaft | A595 or A572 | 55 |
| Pole base | A36 | 36 |
| Galvanizing structure | A123 | — |
| Galvanizing hardware | A153 | — |
| Arm shaft | A595 or A572 | 55 |
| Arm connection | A36 | 36 |
| Arm connection bolts | F3125 GALVD. TO A153 | — |
| DTI washers | ASTM F959 | — |
| Luminaire arm shaft | Per manufacturer | 35 |
| Luminaire arm casting | A27GR.65-35 | 35 |
| Luminaire arm connection bolts | SAE GR.5 OR ASTM F3125 | — |
| Plate and channel | A36 | 36 |
| Anchor bolts | F1554 | 55 |
| Ornamental base | Cast aluminum-356 F | — |

ksi = kilopounds per square inch; DTI = direct tension indicating

- (b) The manufacturer shall provide mill certifications for steel materials.
- (c) All poles, arms, transformer bases, and hardware shall be galvanized with powder coating or painted as specified on the plans or by the Engineer prior to installation.
- (d) Ornamental poles shall have a rust-resistant coating applied to the inside of the pole. The color of the outside of the pole will be specified at time of order. All poles, arms, ornamental bases, and hardware shall use one of the following coating systems:
 - (1) Option 1:
 - (i) Primer = DuPont 25P Primer
 - (ii) Top Coat = DuPont 333 Imron
 - (2) Option 2:
 - (i) TGIC polyester powder at a minimum thickness of 2.0 mils

6 Pole Shafts

- (a) There are four size categories of single-arm mast arm poles:
 - (1) 20 to 40 feet
 - (2) 42 to 48 feet
 - (3) 50 to 60 feet
 - (4) 62 to 66 feet

To achieve interchangeability between poles and foundations, all of the poles in a size category shall have the same base plate size and bolt pattern.

- (b) There are four size categories of dual-arm mast arm poles:
 - (1) 20 to 40 feet
 - (2) 42 to 48 feet
 - (3) 50 to 60 feet
 - (4) 62 to 66 feet

The lengths listed are the longest arm. To achieve interchangeability between poles and foundations, all of the poles in a size category shall have the same base plate size and bolt pattern.

- (c) Pole shafts shall be 26 feet tall. The mast arm connection shall be located 15 feet above the base of the pole. The luminaire arm connection shall be located 25 feet and 6 inches above the base of the pole.

Truncated pole shafts (poles without extra height for luminaires) shall be 2 feet taller than the top of the connection plate. The design of the pole should assume conditions for a pole with luminaire arm.

- (d) The shaft shall be one piece, and contain no circumferential weld butt splices. The pole shaft shall have 16 sharp flutes and shall have a constant linear taper of 0.14 inch per foot. Laminated tubes or round poles with separate fluted sheeting are not permitted. The flutes shall terminate 6 inches above the base plate connection. The minimum thickness of steel shall be 7 gauge.
- (e) Pole diameters at their connections to base plates shall not exceed the diameters listed in Table 4.3.

Table 63-3: Pole Design Shaft Diameter

| Single-Mast Arm Poles | | Dual-Mast Arm Poles | |
|--|----------------|---------------------------|----------------|
| Arm Length (ft) | Max Dia. (in.) | Arm Length (largest) (ft) | Max Dia. (in.) |
| <40 | 18 | <50 | 20 |
| 40-48 | 20 | 50+ | 24 |
| 50+ | 24 | | |
| ft = feet; in. = inches; dia. = diameter | | | |

- (f) Identification tag

Provide an identification tag affixed to the pole with the following information:

- (1) Arlington County, VA
- (2) Manufacturer
- (3) Date of manufacture (MM/YY)
- (4) Pole height and gage
- (5) Arm length and gage
- (6) Anchor bolt diameter and length
- (7) Bolt circle diameter (on center of bolts)
- (8) Serial number

The tag shall be attached between 4 feet and 5 feet above the base of the pole.

- (g) Handholes

- (1) An access hole and J-hook shall be provided on the opposite side of the pole shaft from the mast arm at the same elevation as the center of the mast arm. The access hole at the mast arm height shall have an outside dimension of 4 inches by 6 inches exclusive of reinforcement. The handhole cover shall be

attached to the inside of the pole with a chain to prevent dropping the handhole cover.

A second access hole shall be provided 28 inches above the pole base to the bottom of the access hole. The lower access hole shall be provided on the opposite side from the attachment of the longest mast arm. The lower access hole shall have an outside dimension of 6 inches by 8 inches exclusive of reinforcement. Provide a grounding L-clip welded directly opposite the access hole on the inside wall of the pole.

All handholes shall have a neoprene rubber gasket that is permanently secured to the handhole frame to ensure weather-tight protection. Handholes shall be provided with a bolted-on galvanized steel cover painted to match the pole. The handhole cover shall be removable from the frame.

(h) Connection plate

The mast arm connection plate shall be located 15 feet above the base of the pole. The connection plate shall have an upward angle of 18 degrees from the horizontal plane. See attached drawings.

(i) Ornamental pole top

Each pole shall be provided with a removable ornamental pole top. The ornamental pole top shall be similar in appearance to the one shown on the attached drawing. The attachment mechanism for the ornamental pole top shall be capable of securely holding the pole top onto the pole shaft under the required design loading.

(j) Ornamental base cover

Poles shall be supplied with an ornamental base cover. The ornamental base cover shall be a split base with twin doors at 180 degrees. The height of the base shall be less than 2 feet and 2 inches tall, and the bottom diameter shall be less than the diameter of the supporting drilled shaft.

(k) Luminaire arm

- (1) Poles shall be supplied with an ornamental luminaire arm. The luminaire arm shall be a King Luminaire model KA30-S Scroll Arm or equivalent.
- (2) The luminaire arm connection shall be located 25 feet and 6 inches above the base of the pole. The arm shall extend 6 feet from the pole shaft and have a 20-inch rise accomplished through a reverse curve. The luminaire arm shall have a decorative scroll that attaches to the pole shaft 36 inches below the luminaire arm attachment to the pole shaft.
- (3) The decorative scroll shall attach to the luminaire arm at a tangent approximately in the middle of the arm. A decorative luminaire mounting shall be fastened to the end of the arm.

7 Mast Arms

(a) There are four size categories of mast arms:

- (1) 20 to 40 feet
- (2) 42 to 48 feet
- (3) 50 to 60 feet
- (4) 62 to 66 feet

To achieve interchangeability between arms and poles, all of the arms in a size category shall have the same connection plate size and bolt pattern.

- (b) Mast arms shall have an ornamental bend allowing the arm elevation to rise 5 feet above the connection plate. Mast arms shall be round. Multi-sided and fluted mast arms are unacceptable. Mast arms shall have a constant linear taper of 0.14 inch per foot. The minimum thickness of steel shall be 7 gauge.
- (c) Mast arms up to 50 feet in length shall be manufactured and shipped in one piece. Mast arms 50 feet and longer shall be manufactured and shipped in two pieces with no piece having a length greater than 40 feet. Circumferential welded tube butt splices and laminated tubes are not permitted.
- (d) Wire entrance holes 1-3/8 in diameter shall be drilled into the bottom of the arm every 11 feet starting at a point approximately 9 inches from the free end of the arm. Rubber grommets shall be installed in the wire entrance holes.
- (e) Mast arm cap

Each mast arm shall be provided with an ornamental end cap secured in place with set screws.

8 Anchor Bolts

- (a) A minimum of six fully galvanized anchor bolts shall be supplied for all mast arm poles. There shall be two steel templates provided per pole. All templates shall be fully galvanized.
- (b) Provide galvanized nuts compatible with the anchor bolts as needed to complete the installation. Decorative nut covers shall be provided for all nuts.
- (c) Furnish two flat washers with each bolt/nut/washer assembly. Furnish galvanized DTI washers. Use the size, number, type, and configuration of hardened flat washers the DTI manufacturer recommends for the anchor bolt diameter.
- (d) The following notes shall be included on all plans and/or shop drawings in reference to anchor bolts:
- (1) Pretensioning of all anchor bolts is required and shall be accomplished with the use of DTI washers. Nuts shall be tightened until proper pretensioning is indicated by the DTI washer.

- (2) The maximum clearance between the bottom of the leveling nuts and the top of the concrete is critical and shall not exceed the amount specified on the drawing.

9 High-Strength Bolts

- (a) Provide galvanized high-strength bolts for connections. Provide galvanized nuts compatible with the bolts as needed to complete the installation.
- (b) Furnish two flat washers with each bolt/nut/washer assembly. Furnish galvanized DTI washers. Use the size, number, type, and configuration of hardened flat washers the DTI manufacturer recommends for the bolt diameter.

10 Execution

- (a) Installation of mast arm poles shall include transporting the poles from the Arlington County Trades Center or other designated location to the job site, placing the poles on the proper foundations, and installing luminaire arms if necessary. Once placed, the Contractor must properly clean all poles and remove all labels prior to acceptance.
 - (1) Steel poles shall be placed and securely mounted on concrete foundations.
 - (2) Strain poles and mast arm poles shall have a 3% rake or as specified by the Engineer or the authorized representative such that the pole is vertical under dead loads.
 - (3) All pole accessories including scrolls, nuts, nut covers, handhole covers, mast arm end caps, and pole caps shall be in place prior to acceptance.
 - (4) Installation shall include bolting the mast arm(s) to the pole. Any traffic control required for installation shall be incidental to the installation of the mast arm.
 - (5) Pretensioning of all connection and anchor bolts is required and shall be accomplished with the use of DTI washers. Nuts shall be tightened until proper pretensioning is indicated by the DTI washer according to the instructions detailed by the DTI washer manufacturer.
- (b) Field welding is not permissible without written approval by the Engineer.
- (c) The use of grout under base plates is not permitted.
- (d) Install traffic signal heads and signs within 5 days after mast arm is installed.
- (e) Removal of strain poles shall include the removal of the pole, overhead span wire, and any equipment on the pole or span. The Contractor shall check with the County representative on whether to salvage and return the pole. The foundation of the pole shall be removed to a minimum of 2 feet below grade or as required for installation of the new pole.

- (f) Removal of mast arm poles shall include removal of the pole including the mast arm from the site. The Contractor shall check with the County representative on whether to store it or dispose of it. The foundation of the pole shall be removed as per County specifications.
- (g) Removal of wood poles shall include removal of the wood pole from the site and disposal of the pole by the Contractor. The hole remaining shall be backfilled with select material and compacted to a density of 95%. The area disturbed by removal of the pole shall be patched with cold mix asphalt.
- (h) Removal of down guy shall include the removal and disposal of the guy strand, guy guard, guy anchor rod, and associated hardware from the pole. The Contractor shall dispose of these materials at its own expense.

11 Measurement and Payment

- (a) Signal poles shall be measured and paid for at the contract unit price per each. This shall include mast arms, flange plates, anchor plates, bolts, transformer bases, painting, welding, labor, and all other associated equipment and hardware required for installation.
- (b) Luminaire arms shall be measured and paid for at the contract unit price per each. This shall include mounting, LED lamp, photocell, and all other associated equipment and hardware required for installation.
- (c) Removal shall be paid for at the contract unit price per each. This shall include the removal of all strain poles, mast arm poles, wood poles, and down guys as described above, as required for installation of the new pole.
- (d) Ornamental base covers shall be measured and paid for at the contract unit price per each.

Section 13164: Traffic Signal Conduit

1 Materials

- (a) Polyvinyl chloride (PVC) conduit shall be schedule 40, schedule 80, or high-density polyethylene (HDPE) as determined on the plan set or as directed by the County representative. All couplings, elbows, bushings, and other conduit fittings shall be of the same quality, strength, and grade of workmanship as the conduit and shall be manufactured expressly for use with the conduit.
- (b) Steel conduit and fittings shall be galvanized and heavy wall and shall meet ANSI C80.1, American National Standard for Electrical Rigid Steel Conduit, and UL 6, Electrical Rigid Metal Conduit – Steel. All couplings, elbows, bushings, and other conduit fittings shall be of the same quality, strength, and grade of workmanship as the conduit and shall be manufactured expressly for use with the conduit.
- (c) All transitions from HDPE pipe to PVC shall be by means of an aluminum threaded coupling or ETCO E-LOC couplings. These couplings are the only approved method for connecting the 90 degree sweep.

2 Execution

- (a) General conduit installation
 - (1) Where multiple conduits are installed in a single trench, the conduits shall be separated by 1 inch of sand or by prefabricated conduit spacing units.
 - (2) Conduit direction changes shall be accomplished by using standard elbows or field bends. All bends shall meet the requirements in NEC Article 346 for rigid metallic conduit and NEC Article 347 for rigid non-metallic conduit.
 - (3) There shall be no more than the equivalent of four quarter bends (360 degrees total) between pull points (e.g., conduit bodies and boxes).
 - (4) Steel conduits shall be cut with a roller cutter. Cutting conduits with a hand saw or power saw is not acceptable.
 - (5) The ends of the conduit shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for the full circumference of the conduit.
 - (6) All couplings shall be tightened until the ends of the conduits are brought together, providing a good electrical connection throughout the entire length of the conduit run. All conduit connections shall be accomplished with threaded ends.
 - (7) When conduit is cut and threaded, corrosion protection shall be applied to the newly cut threads and ream area. Prior to applying any coating, the Contractor shall thoroughly clean the thread and ream area with a degreaser spray to

remove all cutting oil and metal chips. When the threads are clean and dry, a coating of cold galvanizing compound or a zinc-rich galvanizing compound (similar to Rustoleum Hard Hat or CRC Instant Cold Galvanize) shall be applied to the threads and ream area.

- (8) All conduits terminating in a junction box, pole base, or controller cabinet shall be threaded and provided with a grounding bushing. The grounding bushings shall be bonded together with grounding wire. Where non-metallic conduit is used, conduit ends shall have protective end bushings installed.
- (9) Conduit risers shall be rigid metallic conduit and attached with conduit clamps. A rain-tight entrance cap with plastic wire entry knockouts shall be installed at the top of each riser. The rigid metallic conduit riser shall extend a minimum of 18 inches into the ground and shall be continuous to the junction box or foundation.
- (10) A 500-pound test strength nylon pull line shall be installed in all conduits.
- (11) Concrete-encased PVC conduit shall have a minimum of 3 inches of concrete on the top, bottom, and sides of the conduit, with 1-1/2 inches of spacing between conduits.
- (12) All underground conduit runs shall have a tracer wire (14 AWG stranded thermoplastic high-heat-resistant nylon-coated [THHN]) installed from junction box to junction box. Multiple conduit runs in the same trench shall have tracer wire in at least one conduit.
- (13) The Contractor, at the Contractor's sole expense, may use larger conduit if desired—except where entering a cabinet foundation. Where larger conduit is used, it shall be for the entire length of the run. Reducing the number of couplings underground will not be permitted.
- (14) All conduits shall terminate in junction boxes such that when cable is pulled and coiled within the junction box there is a minimum clearance of 3 inches between the junction box lid and the conduit and cable. Cable and conduit shall not be crushed or damaged.
- (15) The ends of all metal conduits, existing or new, shall be well reamed to remove burrs and rough edges. Field cuts of existing or new conduit shall be made square and true, and the ends shall butt together for the full circumference of the conduit. Slip joints or running threads will not be permitted for coupling metal conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. All couplings shall be screwed tight until the ends of the metal conduits are brought together.
- (16) Where a "stub out" is called for on the plans, a sweeping ell shall be installed in the direction indicated and sealed with a metallic cap to facilitate locating. The locations of all conduit ends in structures or terminating at curbs shall be

marked by a “Y” at least 3 inches high cut into the face of the curb, gutter, or wall directly above the conduit.

- (17) Where factory bends are not used, conduit shall be bent without crimping or flattening, using the longest radius practicable. Conduit bends feeding junction boxes and foundations shall be as shown on the standard details, typically 18 inches.
 - (18) Conduits shall always enter a pedestal base, junction box, or any other type structure from the direction of the run only. Conduit connections at junction boxes shall be tightly secured.
 - (19) Conduits terminating in a standard or pedestal shall extend approximately 2 vertical inches above the foundation.
 - (20) All conduit runs that are more than 10 feet long shall have a continuous 1/8- or 1/4-inch nylon rope (blow line cannot be substituted but can be added) pulled into the conduit along with the specified electrical cables. The line shall be firmly secured at each end of the conduit run with a minimum slack of 4 feet. The purpose of the rope is to provide a means of pulling electrical cable through the existing conduit runs. The rope shall not be tangled or twisted around cables.
 - (21) Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or blown out with compressed air.
 - (22) New conduit runs shown on the plans are for bidding purposes only and may be changed at the direction of the Engineer.
 - (23) Any spare or unused conduits installed for future use shall be sealed with a metallic cap and a single 14 AWG stranded THHN wire through the entire run to facilitate future locating.
 - (24) All conduit installed, including HDPE pipe, shall be at full depth for the entire conduit run. Ninety-degree sweeps shall not be cut to achieve proper entrance to the junction box. Conduit runs shall have no more than a 180-degree bend.
 - (25) All conduits in junction boxes shall extend a minimum of 3 inches above crushed rock.
- (b) Trenching
- (1) Unless otherwise shown or approved by the Engineer or authorized representative, conduits shall be placed at a minimum depth of 36 inches within Arlington County ROWs. Within VDOT ROWs, in accordance with VDOT regulations, all conduits shall be buried with a minimum of 36 inches of cover.
 - (2) All trenching shall conform to Arlington County Construction Standards and Specifications; Section 02200, Earthwork; and Section 02650, Restoration of Roadway.

- (3) Trenches shall be free of cinders, broken concrete, and other hard abrasive materials before conduit placement.
 - (4) The Contractor shall take measures to preserve the existing landscaping. When trenching in earth, the Contractor shall carefully remove the existing sod and then put the new sod into place when the work is complete. The Contractor shall put all earth that has been excavated on a plastic sheet to protect the existing landscaping.
 - (5) The Contractor shall completely restore the trench at the end of every work day. Restoration shall include backfilling, compacting, and placing the sod.
 - (6) Boring under the sidewalk/street shall involve boring runs from 30 to 100 feet (typical) or more in length. The Contractor may use the directional bore method instead of trenching or backfilling. Boring may be under asphalt paving, concrete sidewalk, or grass.
 - (7) Test holes shall be dug in asphalt paving per the Virginia Professional Excavator's Manual and Miss Utility guidelines for test pits.
- (c) Boring
- (1) The Contractor shall be required to dig test pits where new conduit crosses underground utilities, as specified on the plans or as directed by the Engineer, to ensure that adequate utility clearances are met.
 - (2) Bored conduits shall adhere to the same depth requirements as trenched conduits and shall adhere to appropriate clearances from utilities.

3 Measurement and Payment

- (a) **Direct Bore Conduit** shall be measured and paid for on a linear-foot basis. Installation shall include conduit bodies, fittings, bonding systems, pull ropes, pull tapes, plastic spacers, 14 AWG stranded THHN when required, junction or splice boxes with an area of 512 cubic inches or less, supports, aggregate, and protective metal shields.
 - ~~(1) Conduit boring cost shall include the cost of all necessary test pits as well as full restoration of the test pits in concrete, asphalt, grass, etc.~~
- (b) **Test Pit** shall be measured and paid for per each.
- (c) **Trenching** shall be measured and paid for on a linear-foot basis and shall not vary for the depth or number of conduits required.
- (d) The cost of restoration shall be included in the unit costs for all items in this section. Restoration shall include, but shall not be limited to, concrete work, asphalt repair, pavers, and sod. Replacement of concrete and asphalt due to boring or trenching shall be incidental to the cost of installing the conduit.

- (1) Restoration in asphalt areas shall include perimeter seal where required by VDOT.
- (2) Concrete panels shall be removed to the nearest control joint and replaced. No re-entering corners shall be permitted on concrete repairs.
- (3) Restoration of paver areas shall include grouted or sand based pavers as needed.

Section 13165: Traffic Cables

1 Materials

(a) Vehicular and pedestrian signal heads

- (1) Signal heads must be wired with #14 AWG 7 conductor cable.
- (2) The conductor cable shall be stranded copper. Each conductor shall be insulated with polyethylene and twisted for maximum flexibility. Grouped conductors shall be covered by a PVC outer jacket. Cable must meet the IMSA 19-1 cable specification.

(b) Intersection lighting

- (1) Intersection lighting must be wired with #12 AWG 2 conductor underground feeder cable with ground.
- (2) Conductors shall be soft uncoated copper per ASTM Standard B3, Standard Specification for Soft or Annealed Copper Wire. Conductor insulation and jacket shall be color-coded PVC rated at 90°C.
- (3) Grounding conductor shall also be soft uncoated copper per ASTM B3. Conductors are to be encased in a gray sunlight-resistant PVC jacket that is applied directly over and around the insulated and bare conductors.
- (4) Insulated conductors and ground are to be laid parallel within the jacket.

(c) Pedestrian pushbuttons

- (1) Pushbuttons must be wired with #14 AWG 3 conductor cable.
- (2) Cable shall be stranded copper. Each conductor shall be insulated with polyethylene and twisted for maximum flexibility. Grouped conductors shall be covered by a PVC outer jacket. Cable must meet the IMSA 19-1 cable specification.

(d) Video detection cable

Video cable must be RG-59 solid center coax cable (RG-59/U rated or better).

(e) Extra high-strength strand cable (span wire)

Strand cable shall be 3/8-inch galvanized steel (Class A) with seven wires per stand. The minimum breaking strength shall be 15,400 pounds.

(f) Ground wire

Ground wire shall be #8 AWG bare copper wire.

(g) Electrical Service Cable

Service cable shall be #6 Copper underground electric cable and be UL approved.

2 Execution

- (a) Cables shall be installed by using existing pull rope, new jet-lined pull rope, or similar rope to pull the cable.
- (b) Unless otherwise approved by the Engineer, wiring shall not occupy more than 40% of the inside area of throughout the conduit. The Contractor shall verify the existing conduit is less than 40% full prior to pulling new cables through. If more than 40% of the inside area is occupied, the Contractor shall provide additional conduit to satisfy this requirement.
- (c) The Contractor shall proof new conduits prior to pulling cables to ensure the cables can be pulled without damaging existing cables.
- (d) The Contractor shall replace pull ropes if used to install new cables in existing conduits. If no pull rope existed in the conduit, a new pull rope shall be installed.
- (e) Cables shall not be spliced within conduits. Wiring shall conform to the appropriate articles of the NEC wiring within cabinets, junction boxes, and similar equipment and shall be neatly arranged.
- (f) Powdered soapstone, talc, or other approved lubricant shall be used when placing conductors in conduit.
- (g) A 1/8- or 1/4-inch nylon pull rope shall be installed in all new conduits and in all existing conduit where a cable is added or an existing cable is replaced. A minimum of 4 feet of slack shall be left in each conduit at each termination.
- (h) At least 5 feet of slack shall be left for each conductor at each span wire support pole.
- (i) Splices shall be kept to a minimum and are allowed only in junction boxes and at pole bases. A minimum of 24 inches of slack shall be left on each splice wire. In no case shall any shellac compounds be used.
- (j) Detector loop lead-in splices in junction boxes shall be fully waterproofed using a splice kit or epoxy wire nuts (Buchanon BTS2 or BTS4 or approved equivalent). A minimum of 12 inches of slack shall be left on the detector loop.
- (k) When conductors and cables are pulled into the conduit, all ends of conductors and cables shall be taped to exclude moisture and remain as such until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped and marked.
- (l) All wiring shall use 19 or 21 conductors per cable for high voltage (exceeding 50V). Conductor cable shall be installed where required in the design plans. Overhead cable shall be secured to messenger cable with cable rings or stainless steel wire wrap only.

- (m) Signal heads mounted on mast arms shall be wired individually from the head to the handhole at the bottom of the pole.
- (n) Four-approach intersections shall be initially wired to all poles to handle eight vehicle phases plus four pedestrian phases following NEMA standard phasing or per plans. Tee intersections shall be initially wired to all poles to handle at least five vehicle phases and three pedestrian phases. At least three spare conductors shall be provided from the controller cabinet to the handhole of each signal pole.
- (o) Span wire and tether cable shall be affixed to the pole using short bail strand vises. If required by the Engineer, insulators shall be provided, and long bail strand vises shall be used.
- (p) Removal of signal cable in conduit shall consist of removing and disposing of the cables in an existing conduit. The pull rope and tracer wire in the conduit shall remain and shall not be removed with the cable. The Contractor shall not damage cables remaining in the conduit and is responsible for repairing any cables damaged as a result of the removal.
- (q) Conductor Labeling: A small permanent plastic tag on which the direction and phase is printed shall be securely attached near the end of each conductor or group of conductors grouped per phase or function at each controller and signal pole. Loop detector lead-ins shall be tagged in the splice junction box behind the curb.

3 Measurement and Payment

- (a) **Furnish Cable.** shall be measured and paid for on a linear foot basis.
- (b) **Install Cable** will be measured and paid for on a linear foot basis. Several cables pulled into a single conduit at the same time shall be considered as a single pull. Cost for pulling cables shall include all connectors, splice enclosures, or other appurtenances. For cables pulled to cabinet, price includes termination in the cabinet.
 - (1) Installing any necessary cables in the poles and arms shall be measured in the same way as conduit (per linear foot). Several cables may be installed in each pole/arm. The pulling of multiple cables in traffic poles and arms shall be considered one pull. No separate payment will be made for each cable.
 - (2) The cost of installing or replacing pull rope shall be incidental to the cost of pulling cable.
- (c) **Remove Cable** shall be measured and paid for on a linear foot basis. Several cables removed from a single conduit, arm, or pole shall be considered a single item.

Section 13166: Foundations

1 County Standards

The detail drawings in the Arlington County Traffic Signal Standards that are applicable to foundations are as follows:

- (a) 66-01 Cabinet Foundation (1 of 2)
- (b) 66-02 Cabinet Foundation (2 of 2)
- (c) 66-03 Strain Pole Foundation
- (d) 66-04 Pedestal Pole Foundation
- (e) 66-05 Mast Arm Pole Standard Foundation Notes
- (f) 66-06 Mast Arm Pole Standard Foundation Types
- (g) 66-07 Mast Arm Pole Standard Foundation

2 General

- (a) Foundations (for cabinets, pedestrian poles, strain poles, and street lights) shall be poured in accordance with the drawings in the Arlington County Construction Standards and Specifications and Arlington, Virginia Department of Environmental Services Traffic Signal and Streetlight Specifications unless otherwise specified by the Engineer.
- (b) Specifications for mast-arm, strain pole, and pedestrian pole foundations shall follow 66-01 through 66-04 of the County's signal specification unless directed otherwise by the County's authorized representative prior to the construction.
- (c) All signal mast arm pole foundations will have six bolts.

3 Materials

Concrete shall be mixed and poured in accordance with Section 03100 of the Arlington County Construction Standards and Specifications. Concrete shall be of the highest class type per the latest edition of the VDOT Standard Specifications for Road and Bridge Construction.

4 Execution

- (a) Forms shall be true to line and grade. Tops of foundations, except as noted on design plans, shall be finished to curb or sidewalk grade or as ordered by the Engineer. The Contractor is responsible for coordinating on any adjacent project to confirm correct final grades.

- (b) Forms shall be rigid and must be securely braced in place and inspected before the concrete is poured. Conduit ends and anchor bolts shall be placed in proper position and in a template until the concrete sets.
- (c) The Contractor shall contact the County for the inspection of forms and reinforcing cage prior to pouring concrete.
- (d) Anchor bolts shall conform to the manufacturer's specifications. Each bolt shall have two flat washers and two nuts. Shims or other similar devices for plumbing or raking will not be permitted. Stirrups shall be installed on all foundations.
- (e) Anchor bolts shall extend the required distance above the top of the foundation to allow the appropriate length beyond the leveling nuts.
- (f) The forms, as well as any ground that will be in contact with the concrete, shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.
- (g) Whenever excavation for a foundation requires removal of excess ground material, the excavation shall be backfilled to within 12 inches of ground level with 60 to 120psi Class M concrete and then backfilled to ground level with native material compacted per the Engineer's direction.
- (h) All foundations shall be hand floated until the top is smooth and level.
- (i) Pole foundations shall be poured against undisturbed earth. Cast-in-place foundations shall be poured monolithically where practicable. The exposed portions shall be formed to present a neat appearance.
- (j) Conduit directions and quantities shall be marked into foundation concrete per VDOT specifications in the latest edition of Standard Specifications for Road and Bridge Construction.
- (k) Top of foundations shall be flush with surrounding concrete when located in sidewalk or paver areas.
- (l) Pole foundation demolition shall consist of the demolition of signal/streetlight pole foundation to a depth of 24 inches below finished grade. **Cabinet foundation demolition shall include the removal of the entire foundation.** Demolition shall include breaking out concrete and removing anchor bolts, conduits, cable, and reinforcing steel, if any. Any conduit runs associated with an abandoned foundation shall be capped or abandoned as called for on the design plans.
- (m) The Contractor shall not leave foundation holes uncovered or unprotected. The Contractor is responsible for ensuring pedestrian safety throughout the installation of the foundation.
- (n) A 5/8-inch by 8-foot copper-clad grounding rod shall be installed in each cabinet foundation. The cabinet foundation grounding rod shall have a non-metallic sleeve (PVC) to prevent contact with the concrete foundation.

- (o) Extending the cabinet foundation shall include the installation of a concrete foundation adjacent to an existing cabinet foundation. The foundation extension shall follow the reinforcing and depth requirements outlined in standard cabinet foundation installations. The Contractor shall set anchor bolts for larger size cabinet as directed by the County. The Contractor shall dowel newly formed section of foundation into existing concrete foundation. The Contractor shall include a minimum of (1) 2" PVC conduit in the extension and shall connect the conduit as directed by the County or as shown on the plans.

5 Measurement and Payment

- (a) **Install Foundation** shall be measured and paid for per each Foundations shall include foundation design, concrete, reinforcing steel, stub poles, anchor bolts, bolt circle templates, grounding equipment, conduits, excavating, backfilling, compacting, disposing of surplus and unsuitable materials, and restoring existing areas. ~~Removal and replacement of existing concrete, asphalt, or brick sidewalk and/or pavement due to installation shall be incidental to the concrete foundation item.~~
 - (1) All reinforcement shall be incidental to the pay item for which a foundation is required. Grounding rods shall be provided as indicated in the standard details and shall be incidental to the installation pay item.
 - (2) If a foundation is installed to the incorrect grade, the Contractor shall remedy the error by removing the foundation and replacing the entire structure.
- (b) **Enter Existing Foundation** shall be paid for at the unit price for each foundation entered, regardless of the number of conduits being installed.
- (c) **Remove Foundation** shall be measured and paid for at the contract unit price for each type of demolition.
- (d) **Extend Cabinet Foundation** shall be measured and paid for per each. Conduit installation beyond the foundation shall be measured and paid for separately. Cost shall include excavation, materials, and labor required for the installation of the extension.
 - (1) Cost shall include foundation design, concrete, reinforcing steel, stub poles, anchor bolts, bolt circle templates, grounding equipment, conduits, excavating, backfilling, compacting, disposing of surplus and unsuitable materials, and restoring existing areas.
- (e) In all items above, the cost of restoration shall be included in the unit costs. Restoration includes, but is not limited to, concrete work, asphalt repair, pavers, and sod.

Section 13167: Pedestrian Signal Poles and Equipment

1 County Standards

The detail drawings in the Arlington County Traffic Signal and Streetlight Standards that is applicable to pedestrian signal poles and equipment is as follows:

67-01 Pedestal Pole Mounting and Pedestrian Signals

2 Materials

(a) Pedestal Poles

- (1) Pedestrian signal poles shall be 4-1/2" outer diameter, spun aluminum, and cut to the height specified on the design plans.
 - (2) Aluminum poles shall be in accordance with VDOT Standards and Specifications.
 - (3) Poles shall only be powder-coated black where indicated on the plans or as directed by the County Engineer.
- (b) Pedestrian signal heads shall be 16-inch LED countdown style. The color of the housing shall be yellow unless noted on the plans.
- (c) Accessible Pushbutton Stations shall be vibro-tactile type, Polara style, accessible pushbutton systems per Section 13168. This type of pushbutton is the County Standard for all new pushbutton installations.
- (d) Mushroom Style Pushbuttons shall be permitted only for maintenance of existing pushbuttons, temporary installations, or as directed by the County Traffic Signal Engineer.

3 Execution

- (a) The Contractor shall verify the location and visibility of the pedestrian signals in the field. If the pole needs to be relocated or the signal locations adjusted, the Contractor shall contact the County prior to pouring foundations or installing heads.
- (b) For Pedestrian signals, the countdown signals must start with the beginning of the flashing Don't Walk indication.
- (c) Remove Pedestrian Signal shall consist of removing the existing signal head from the pole, and includes disconnection and removal of existing cables, and removal of the signal housing and insert (to be salvaged and returned to the County unless directed otherwise).
- (d) Adjust Pedestrian Signal shall consist of modifying the existing mounting and rotating the existing pedestrian signal head to the new orientation. This task also includes re-termination of wires in the cabinet where required to accommodate changes in phasing.

- (e) Install Pedestrian Signal shall consist of mounting the signal head on a pedestal or signal pole and terminating the electrical connections in the head. The countdown signals must start with the beginning of the flashing Don't Walk indication.
- (f) Install LED Module in Pedestrian Signal Housing shall consist of replacing the LED module including all terminations. The Contractor shall dispose of the old LEDs or return to the County as directed by the Construction Manager.
- (g) Install Pedestal Pole shall include obtaining the pole, transporting it to the job site, and securely fastening the pole to new or existing foundation. Installation also includes installing the pole cap and the pole base.

4 Measurement and Payment

- (a) **Furnish Pedestal Pole** shall be measured and paid for per each. Material cost shall include the pole, and all associated hardware required for installation, including pole base and cap.
- (b) **Furnish Pedestrian Signal** shall be measured and paid for per each. Material cost shall include the signal insert, housing, mounting hardware, visors, and all associated hardware required for installation.
- (c) **Furnish Pushbutton** shall be measured and paid for per each and shall include the pushbutton (mushroom style) and all associated hardware required for installation.
- (d) **Install Pedestal Pole** shall be measured and paid for per each.
- (e) **Install Pedestrian Signal** shall be measured and paid for per each.
- (f) **Install Pedestrian Pushbutton** shall be measured and paid for per each.
- (g) **Remove Pedestal Pole** shall be measured and paid for per each.
- (h) **Remove Pedestrian Signal** shall be measured and paid for per each.
- (i) **Adjust Pedestrian Signal** shall be measured and paid for per each.
- (j) **Install LED Countdown Module** shall be measured and paid for per each.

Section 13168: Accessible Pushbutton System

1 County Standards

The detail drawings in the Arlington County Traffic Signal Standards that are applicable to the accessible pushbutton system (APS) are as follows:

- (a) 68-01 Accessible Pushbutton Station
- (b) 68-02 Polara APS Ordering Information

2 Materials

- (a) Pushbutton station, signs, and all component parts must be of Polara type and meet the latest edition of applicable NEMA and UL standards.
- (b) Central Control Unit with Ethernet (CCU2EN)
 - (1) The Central Control Unit (CCU) shall be installed inside the traffic cabinet and powered by the AC supply mains (115VAC). The CCU is the power supply and signaling interface between the existing intersection of the traffic control unit and APS stations.
 - (2) One EZ Communicator CCU2EN can control up to 16 Ethernet Adaptor (EN2) Pushbutton Stations (PBSs), four maximum per channel.
 - (3) The CCU2EN controls up to four pedestrian channels, receiving its timing from the Walk and Don't Walk signals.
 - (4) All inputs and outputs have full optical isolation and include voltage protection.
 - (5) The CCU2EN has two built-in conflict monitoring systems. The CCU2EN monitors the PBS and Ped-Head lights and powers off the channel upon a conflict. Each processor monitors the other monitors and resets the CCU2EN upon loss of internal communication.
 - (6) The CCU2EN is backward compatible with older 2-wire Navigator N2 PBSs (v1.12 or newer). There is an option switch on the back of the CCU2EN that specifies N2 or EN2. If all PBSs are EN2 PBSs, the EN2 position is used. If any of the PBSs are older 2-wire N2 PBSs, the N2 position must be used.
 - (7) The Ethernet port adds a connection to an on-board web server, which provides information on PBS status, an event log, and remote configuration of EN2 PBS options.
 - (8) Serial numbers and model numbers, if available, shall be permanently engraved on all removable components and hardware. The serial number and model number shall be etched, stamped, molded, or attached using metallic self-adhesive labels. Adhesive-backed paper labels are not acceptable.

- (9) APS stations and signs will be designed 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.
- (10) APS stations and signs shall be designed to the following:
 - (i) Each station will have a 2-inch button with a tactile raised directional arrow on the button.
 - (ii) It shall be possible to change the arrow direction to one of four directions.
 - (iii) Arrow/button shall vibrate during the walk period following a push of the button.
- (11) APS stations and signs will have the following features:
 - (i) Locating tone
 - (ii) A direction of travel and an information message with extended push
 - (iii) Vibro-tactile walk phase indication
- (12) The audible sounds emitted by APS stations and signs shall have the following properties:
 - (i) All audible sounds emanate from the PBS.
 - (ii) All audible sounds from PBSs are synchronized.
 - (iii) All sounds automatically adjust over a 60 dB range to compensate for ambient noise levels.
 - (iv) Sounds at all crosswalks except activated crosswalks can be muted.
- (13) APS station and sign systems shall meet the following requirements:
 - (i) The system shall be able to play an emergency preemption message.
 - (ii) The system shall be able to self-test buttons and report any faults to the traffic controller.
- (14) Audible messages shall conform to the 2009 MUTCD Rev. 2, Section 4E, and the following:
 - (i) If speech walk messages are used to communicate the walk interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies. Speech walk messages shall be used only at intersections where it is technically infeasible to install two accessible pedestrian signals at one corner separated by at least 10 feet.
 - (ii) Speech walk messages that are used at intersections having pedestrian phasing that is concurrent with vehicular phasing shall be patterned after the model "Broadway. Walk sign is on to cross Broadway at 1st."

- (iii) Speech walk messages that are used at intersections having exclusive pedestrian phasing shall be patterned after the model "Walk sign is on for all crossings."
- (iv) Speech walk messages shall not contain any additional information, except that they shall include designations such as "Street" or "Avenue" where this information is necessary to avoid ambiguity at a particular location.
- (v) Vibro-tactile walk phase indication shall be triggered during each walk indication.
- (vi) Following the audible walk indication, accessible pedestrian signals shall announce the pedestrian change interval countdown "10, 9, 8... etc."
- (vii) A speech walk message is not required when the walk interval is not active, but if provided:
 - (A) It shall begin with the word "wait." Speech wait messages shall be patterned after the model "Wait to cross Broadway at 1st. Wait."
 - (B) It need not be repeated for the entire time the walk interval is not active, but each push of the button shall be accompanied by the speech message patterned above.

(15) The pushbutton will be warranted for 5 years from the date of shipment from the factory. Proof of warranty shall be provided to the County from the Contractor.

3 Execution

- (a) Installation of the APS shall consist of drilling holes in the signal pole to accommodate the wiring and mounting, tapping threads into the pole, and making the necessary electrical connections and running the cable between signal heads and pushbutton.
- (b) The pushbutton apparatus shall be bolted to the pole 3.5 feet above grade (from the center of the button) with bolts extending out from the rear of the apparatus and into the pole.
 - (1) Where an ornamental pole base extends above the mounting height of the pushbutton, an extender shall be provided to allow for easy wheelchair access. The extender shall be Polara type 6" or 12" in length, depending on field conditions.
- (c) The Contractor shall program the APS per County specifications for the audible messaging. All programming is the responsibility of the Contractor. The Contractor shall check operation of vibro-tactile (Polara) pushbutton announcements with street names and locator tone and adjust the sound level if necessary.

- (d) The Contractor shall disable audible messages and locator tone until full functionality and programming is completed.
- (e) The Contractor shall install the CCU in the cabinet per standard cabinet equipment layout, terminate all connections into the cabinet, and fully wire pushbutton systems.
- (f) Programming of the pushbutton shall conform to Arlington County Traffic Signal Standard 68-02.
- (g) A plaque shall be mounted on the APS unit showing the “walking man” facing the correct direction per County standards.

4 Measurement and Payment

- (a) **Furnish APS** will be measured and paid for per each.
- (b) **Furnish APS Central Control Unit (CCU)** will be measured and paid for per each. For all new installations the CCU2EN shall be used.
- (c) **Furnish EZ Communicator Navigator Configurator** will be measured and paid for per each.
- (d) **Install APS** shall include necessary programming and installation of the APS station, sign, labor, equipment, tools, and incidentals. Installation shall include the installation of the CCU2EN in the cabinet as well as all terminations necessary for the system to function.
- (e) **Furnish and Install APS System** shall include all required materials including pushbutton stations, EZ Communicator, CCU2EN, programming, installation and wiring of the system, testing, and any required extenders needed to make stations accessible.

Section 13169: Emergency Vehicle Preemption Systems

1 Materials

- (a) Optical detectors for emergency vehicle preemption shall be the GTT Opticom Model 711 or 721 Optical Detector or latest model, as needed. Placement of the detectors shall be determined by the Engineer.
- (b) Timer modules for the EVP system shall be the GTT Opticom Discriminator, Model 764, which handles two channels of detection.
- (c) The optical emitter for EVP system shall be the latest GTT Opticom model. The emitter shall be programmable for priority and identification purposes via internal switches. The on-board emitter shall transmit industry-standard carrier frequency for emergency band signals (14.035 +/- 0.003Hz) or for transit band signals (9.639 +/- 0.0014Hz).

2 Execution

- (a) Installation shall consist of installing detectors per the design plans and all associated wiring in the cabinet.
- (b) The Contractor shall program the controller per County guidance.
- (c) The Contractor shall ensure that the detectors and discriminator module are working properly prior to scheduling an inspection with the County.
- (d) Integration shall include the controller programming, installation and testing of the discriminator module, and adjustment or relocation of existing cabinet equipment in order to accommodate the module in the cabinet.

3 Measurement and Payment

- (a) **Furnish Optical Detector** shall be measured and paid for per each and shall include all mounting hardware and connectors required for installation.
- (b) **Furnish Preemption Cable** shall be measured and paid for per linear foot.
- (c) **Furnish Discriminator Module** shall be measured and paid for per each and shall include all hardware required for installation.
- (d) **Install Optical Detector** shall include labor, mounting, aligning, and re-aligning per the Engineer, pulling cable to cabinet, terminating within cabinet, programming of the controller if needed, and testing.
- (e) **Furnish and Install Preemption System** shall include all materials required for installation such as detectors, cable, discriminator module(s). Installation of the detectors, pulling and terminating all cables, installation of the discriminator module,

and testing shall also be included. This item also includes integration of the complete pre-emption system.

- (f) **Furnish Optical Emitter** shall be measured and paid for per each.
- (g) **Integrate Pre-emption System** shall be measured and paid for as a lump sum.

Section 13170: Traffic Signal Control Cabinet

1 County Standards

The detail drawings in the Arlington County Traffic Signal Standards that are applicable to the Traffic Signal Control Cabinet are as follows:

- (a) 70-01 Cabinet Equipment Layout

2 General

- (a) The traffic signal control cabinet assembly shall meet at a minimum all applicable sections of NEMA Standards Publication No. TS2-2003.
- (b) All cabinets for new installations or replacements shall be Size P44, Type TS2, and powder-coated black.
- (c) For temporary pole-mounted installations, a size M, Type TS2 shall be permitted.
- (d) The cabinet shall operate in two distinct modes based on a user-defined software setting. The modes are pre-timed and actuated.
- (e) The cabinet's firmware shall be stored in non-volatile Flash random-access memory.
- (f) The cabinet shall operate in actuated control operation as defined by NEMA TS2-2003, Section 3.4.
- (g) The cabinet shall provide for a minimum of 16 phases, 16 pedestrian, and 8 overlaps.

3 Cabinet Components and Layout

- (a) The layout of the traffic signal control cabinet assembly shall conform to NEMA TS2-2003 and with Arlington County Traffic Standard 70-01.
- (b) The tech panel shall be mounted on the inside of the cabinet door.
- (c) Cabinets shall be pre-wired and tested prior to installation at the intersection.
- (d) The Contractor shall provide documentation of the successful completion of the testing.
- (e) Cabinets shall contain an auxiliary power strip hard wired into the cabinet circuit breaker to provide outlets for equipment.
- (f) The controller interface shall meet the requirements for a Type 1 interface as defined in Section 5.3 of NEMA TS2-2003.
- (g) Malfunction Management Unit
 - (1) The Malfunction Management Unit shall meet at a minimum the requirements of Section 4 of NEMA TS2-2003.
 - (2) The Malfunction Management Unit shall be of type channel-16 LE.

- (h) Bus Interface Unit (BIU)
 - (1) The BIU shall meet the requirements of Section 5.3.1.4 of NEMA TS2-2003.
 - (2) The BIU rack design and signal pin assignment shall meet the requirements of Section 8 of NEMA TS2-2003.
 - (3) The BIU shall contain a ruggedized Category 5e Ethernet data connection.
- (i) Port 1 communications cable shall meet the requirements of Section 5.3.3 of NEMA TS2-2003.
- (j) Switches (general)
 - (1) All toggle type switches shall be heavy duty and rated 15 amps minimum. Single- or double-pole switches may be provided as required.
 - (2) Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact.
 - (3) All switch functions must be permanently and clearly labeled.
 - (4) All wire routed to the police door-in-door and test switch pushbutton panel shall be adequately protected against damage from repetitive opening and closing of the main door.
- (k) Technician Switch Panel

A technician switch panel shall be mounted on the inside of the cabinet. The test switch panel shall contain the following at a minimum:

 - (1) Auto/Flash Switch

When in the flash position, power to the controller shall be maintained, and the intersection shall be placed in flash. The controller shall not be stop timed, and the cyclic operation of the controller shall not be affected when the switch is in the flash position. When the switch is returned to the auto position, the controller shall immediately initiate the start-up sequence.
 - (2) Stop-Time Switch

When applied, the controller shall be stop timed in the current interval.
 - (3) Control Equipment Power On/Off

The switch shall control the controller, conflict monitor, and cabinet power supply.
 - (4) Pedestrian Detector Input

On the technician switch panel, four momentary pedestrian detector inputs should be provided.
- (l) Police Door Switch Panel

The police door switch panel shall contain the following:

(1) Signals On/Off Switch

In the Off position, power shall be removed from signal heads in the intersection. The controller shall continue to operate. When in the Off position, the conflict monitor shall not conflict or require reset.

(2) Auto/Flash Switch

In the Flash position, power shall not be removed from the controller, and stop time shall be applied. If required by the signal plans and specifications, an optional RC network shall be provided to give the controller an external start pulse when the switch is returned to the Auto position, which will force the controller to initiate the start-up sequence when exiting Flash mode.

(3) The RJ-45 port shall be installed with 6-foot category 5E cable.

(m) Generator Switch

(1) The system shall be equipped with an external generator sensing/transfer switch and keyed generator cable receptacle. If an external 120VAC generator is connected to the system, the inverter shall qualify the power from the unit and if it is within the defined parameters, derive its input from the generator, thus providing uninterrupted power to the critical load and recharging the batteries. The transition shall be accomplished without any switching or coupling (other than the cable connection) and with no interruption of power to the critical load from either failure or restoration of generator AC power.

(2) A generator access compartment with an access door shall be mounted in the top third of the main door and shall be equipped with a police key lock and two keys. A cable entryway shall be provided in the bottom of the door with a closure to fully seal the entryway when not used. A twist lock electrical connector shall be mounted to the rear wall within this compartment. The receptacle shall be an HBL-2315 or approved equivalent and shall have a full-coverage boot over the entire rear portion of the unit. The unit shall mate with the generator plugs in use by the County. When the generator plug is connected to the receptacle, it shall be possible to safely close and lock the compartment door securing the system.

4 Warranty

(a) The Contractor shall provide materials with a manufacturer's warranty/guarantee, transferable to Arlington County Department of Environmental Services, that the supplied materials are free from all defects in materials and workmanship for the stated period from the date of shipment. The Contractor shall supply the County Engineer with any warranty/guarantee documents from the manufacturer and a copy of the invoice showing date of shipment.

5 Execution

- (a) Install Ground-Mounted Cabinet shall consist of transporting the cabinet to the specified foundation and then drilling and installing anchor bolts into the foundation, placing a sealant along the bottom flange of the cabinet, and attaching the cabinet to the foundation.

The Contractor is responsible for all connections, terminations, wiring for all equipment in the cabinet (e.g., preemption, video detection, pushbuttons, signals), and labeling of the cables.

- (b) Install Pole-Mounted Cabinet shall consist of transporting the cabinet to the specified pole location, securing the cabinet to the pole using the approved method, drilling the pole and cabinet bottom, and installing conduit bodies and nipples with lock nuts (up to three 2- and 3-inch-pound).

The Contractor is responsible for all connections, terminations, and wiring for all equipment in the cabinet (e.g., preemption, video detection, pushbuttons, signals), and labeling of the cables.

- (c) Install RJ-45 Connector shall consist of installing the RJ-45 connector inside the police panel as well as the Category 5e cable to connect the RJ 45. The Contractor shall provide a cut sheet for RJ-45 connector, cap, and Category 5e cable.

- (d) Removing a cabinet shall include disconnecting all terminations, removing cable to the nearest junction box, and unbolting the cabinet. The Contractor shall salvage as much equipment and/or the entire cabinet and return to the County, depending on the direction from the County.

- (e) Cabinet side entry shall include the entry of a cabinet with conduit through an exterior wall of the cabinet.

(1) The Contractor shall verify entry point prior to drilling hole for conduit entry, and shall avoid damaging existing conduits, equipment, wiring, and operation of the cabinet.

(2) All bends and connection shall have a waterproof seal.

(3) All conduit shall be rigid metallic conduit.

(4) Contractor shall install conduit riser no more than 6" from the exterior of the cabinet.

(5) Conduit shall be bonded to the cabinet grounding system.

6 Measurement and Payment

- (a) **Furnish Cabinet Assembly** shall be measured and paid for per each. Controller cabinet assemblies shall include timing data, timing implementation, training, controller cabinets, back panels, power panels, detector panels, auxiliary panels, police panels, thermostatically controlled fan units in the cabinet with vent, flashers,

local flasher switches, radio frequency interference filters, signal switches, main switches, police hand controls, conflict monitors, flasher relay assemblies, power relays, signal control assemblies, lamp receptacles and ground fault receptacles, circuit programs, flexible cables, grounding systems, transient protection devices, fittings, and all other associated equipment as required.

- (b) **Install Ground-Mounted Cabinet** shall be measured and paid for per each.
- (c) **Install Pole-Mounted Cabinet** shall be measured and paid for per each.
- (d) **Furnish and Install RJ-45 Connector** shall be measured and paid for per each.
- (e) **Cabinet Side Entry** shall be measure and paid for per each. Cost of conduit, condulets, couplings, attachments, bushings, duct seal, and heat shrink tubing shall be incidental.
 - (1) Excavation and restoration required to install side entry shall also be incidental up to 5' from the cabinet. Conduit installed beyond 5' shall be measure and paid for separately.
- (f) **Remove Cabinet** shall be measured and paid for per each. Cost of delivery of salvaged materials or equipment to the County Trades Center shall be incidental.

Section 13171: Traffic Signal Controllers

1 Materials

- (a) Controllers must be compatible with the County's Advanced Traffic Management System (ATMS) and shall be Intelight X-3 controller.
- (b) Controllers shall be furnished with required D-harness adapter.
- (c) Contractor shall provide copies of material warranties to the County.

2 Execution

- (a) Contractor shall notify the County at least 5 working days prior to installing controller.
- (b) Contractor shall ensure appropriate maintenance of traffic and/or police coordination is provided while performing the installation.
- (c) Contractor shall perform bench testing of the controller prior to the installation and shall furnish a bench test acceptance certificate upon request by the County.
- (d) Contractor shall contact the County for timing data at least 3 weeks prior to installation.
- (e) Installation of controllers shall include any required hardware and making all required connections.
- (f) Contractor shall observe the operation of the signal for at least 5 cycles following installation and shall verify that all phases are being serviced, pedestrian detection and signals are functioning properly, and that there are no safety or functional issues with the intersection prior to leaving the site.
- (g) Contractor shall verify controller communications with the County.
- (h) Contractor shall relocate other cabinet components as needed per Arlington County Traffic Standard 70-01. Relocation of cabinet components shall be incidental to the installation of the controller.

3 Measurement and Payment

- (a) **Furnish Controller** shall be measured and paid for per each and shall include D-harness adapter required for preemption connection.
- (b) **Install Controller** shall be measured and paid for per each.

Section 13172: Closed-Circuit Television Cameras

1 Materials

(a) Video codec

Codecs shall be CorTec Universal Digital Video type, model VCX-7401 or approved equivalent. The codec shall be capable of three types of video compression (H.264, MPEG4, and MPEG2). The codec shall accommodate both RJ-45 and USB 2.0 connectors.

(b) Camera

(1) Camera shall be Cohu iDome cameras. All power supplies required to operate the integrated CCTV dome camera shall be included with the camera unit.

- (i) Each camera/lens/housing delivered to the project site shall be accompanied with a written certification of assembly and configuration from the camera manufacturer. The certification shall serve as manufacturer's documentation that the camera/lens/housing equipment were assembled and configured in accordance with the manufacturer's specifications.
- (ii) The Contractor shall supply and install a dome-type environmental enclosure designed to protect the camera, pan/tilt mechanism, and zoom lens from the harsh outdoor environment. The assembly must be supplied with an integral sun shield to reduce glare. The enclosure shall be fully weatherproof.
- (iii) The camera and zoom lens shall be mounted to ensure that the enclosure does not obstruct the field of view (FOV) of the camera. Sufficient clearance between the zoom lens extended to its farthest point of travel and the dome enclosure wall shall be provided to ensure that mirroring on the window will not be captured.
- (iv) A gas-tight connector shall be required for all wiring entries into the camera housing. Wiring to the connector shall be sealed with silicon or functionally equivalent compound.

(c) Cables and connectors

- (1) Connectors shall be provided and installed that are compatible with the communications equipment interface. Connectors shall be used at the control unit and at the camera, zoom lens, and pan/tilt mechanisms. Pressure-tight multi-conductor MS-type cable connectors shall be used for camera, zoom lens, and pan/tilt connections.
- (2) The camera lead-in cables shall meet the manufacturer's specifications for National Television System Committee (NTSC) video transmission,

Recommended Standard (RS)-422 communications, and power.

Cables/adapters shall be supplied for connecting the NTSC, RS-422, and power from the camera/controller to the controller cabinet. CCTV lead-in cables shall be routed as shown on the design plans.

- (3) Strain relief shall be provided for cables to keep cables from being damaged from overstrain or bending due to the vertical rise up the camera poles.
- (4) A CCTV lead-in cable shall be furnished that contains conductors for CCTV unit control, CCTV unit power, and CCTV unit video.
- (5) The run between the installed location of CCTV unit and the signal controller cabinet shall be measured where the CCTV unit will receive power and connect to the communications cable. Cable shall be furnished that is able to conduct control signals, video signals, and power over the measured distance (plus 20%) with signal and voltage drops that allow the unit to operate in accord with the product's recommended technical specifications.
- (6) CCTV lead-in cable shall contain shielding to prevent interference and crosstalk between the data, video, and power conductors.
- (7) The NTSC shall feed into video input #1 on the encoder, and the pan-tilt-zoom EIA-422 interface shall terminate at an EIA-422 to EIA-232 opto-isolated converter. The converter shall connect to the camera control data port of the encoder.

2 Execution

- (a) CCTV systems shall be mounted high enough to adequately see traffic in all directions or as approved by the Engineer. The minimum and maximum heights shall be 20 feet above ground level and 45 feet above ground level, respectively. The Contractor shall ensure that the CCTV camera is mounted higher than the traffic signal heads at the intersection.
- (b) The Contractor shall confirm the location of the camera installation prior to installing.
- (c) Each camera and pan/tilt/zoom mechanism shall be electrically bonded, and the housing to the CCTV camera assembly shall be attached using a #6 AWG braided copper conductor.
- (d) All equipment shall be grounded as required.
- (e) Surge protectors shall be installed on all ungrounded conductors entering the CCTV enclosure.
- (f) Removal of CCTV Camera shall include the removal of the camera unit, all lead-in cable, and the mounting bracket (if camera is not to be replaced).
- (g) CCTV Maintenance shall include washing the camera dome housing with a non-abrasive cloth such as terry cloth or microfiber. Contractor shall use a mild detergent

suitable for polycarbonate. Contractor shall check cables and connectors for abrasion and corrosion.

3 Measurement and Payment

- (a) **Furnish CCTV Camera** shall be measured and paid for per each and shall include the camera and all associated accessories including the camera unit, camera lenses, control circuits, accessories, camera housing, pan and tilt units, camera control receivers, cable harnesses, connectors, equipment for accommodating presets, source identification generator, all mounting brackets and poles, mounting hardware (e.g., screws, nuts, bolts), power cords, and transformers. CCTV Camera cost includes factory testing and warranty.
- (b) **Furnish CCTV Lead-in Cable** shall be measured and paid for per linear foot.
- (c) **Furnish Video Encoder** shall be measured and paid for per each.
- (d) **Furnish and Install CCTV System** shall be measured and paid for on a lump sum basis. This shall include furnishing and installing the camera unit, camera lenses, control circuits, accessories, camera housing, pan and tilt units, camera control receivers, cable harnesses, connectors, equipment for accommodating presets, source identification generator, all mounting brackets and poles, mounting hardware (e.g., screws, nuts, bolts), power cords, transformers, delivery of all required software, installation and configuration of the CCTV unit, factory certification, and testing.
 - (1) Cost shall also include furnishing and installing CCTV lead-in cable through conduit and mast arms, including all terminations in the cabinet.
 - (2) Cost shall also include furnishing video encoder in the cabinet with power supply and connecting encoder output to switch.
- (e) **Remove CCTV Camera** shall be measured and paid for per each and shall include salvaging or disposing of the existing lead-in cable, camera unit, and mounting bracket. Delivery to County Trades Facility shall be incidental if equipment is required to be salvaged.
- (f) **Install CCTV Camera** shall be measured and paid for per each and shall include the installation of the camera on a mounting bracket on either the mast arm or the signal pole as directed and the necessary terminations. Installation of the lead-in cable shall be paid for separately under Section 13165 - Traffic Cables.
- (g) **CCTV Camera Maintenance** shall be measured and paid for per each.

Section 13173: School Beacon Assemblies

1 Materials

- (a) School beacon assemblies shall be Carmanah R820 Dual type or approved equivalent.
- (b) A typical solar-powered school beacon assembly includes a 15-foot pedestal pole (with base, anchor bolts, and collar), signal heads with hardware, cabinet with solar array and batteries, two 12VDC LED signals, wiring harness, and Applied Information remote school beacon monitoring field device (model AI-0500-070 or approved equal).
- (c) A typical AC-powered school beacon assembly includes a 15-foot pedestal pole (with base, anchor bolts, collar, and pole cap), signal heads with hardware and 120VAC LEDs, cabinet, and Applied Information remote school beacon monitoring field device (model AI-0500-070 or approved equal).
- (d) Either system must have the capability to download programming for school schedule/calendar over cellular network and be compatible with the County's remote-controlled school flasher database system.

2 Execution

- (a) The pole and foundation shall be installed per standards and specifications for pedestrian pedestal pole installation.
- (b) The Contractor shall verify that all proposed improvements are within an existing ROW or on County-owned property.
- (c) The Contractor shall install the assembly and verify proper operation and monitoring prior to acceptance. The Contractor shall field-test the door monitor, lamp monitor, and remote control prior to acceptance.
- (d) The installation of school beacon assemblies shall include the furnishing of all labor, materials, tools, and equipment necessary to install the beacon assembly.

3 Measurement and Payment

- (a) **Furnish Beacon Assembly** shall be measured and paid for per each.
- (b) **Install Beacon Assembly** shall be measured and paid for per each. All miscellaneous hardware required for the installation of the flasher assembly, as well as testing of the unit, shall be included under this item.
- (c) For AC-powered units, the installation of conduit, cable, and meter pedestals shall be paid for under their respective items.
- (d) The cost of the pedestal pole and concrete foundation will be paid for under their respective items.

Section 13174: Uninterruptible Power Supply

1 Materials

(a) A typical uninterruptible power supply (UPS) assembly includes the UPS unit, battery package, auxiliary cabinet, and switching device. UPS systems shall be Alpha FMX1100 type. The UPS assembly shall include the following components:

(1) Inverter/charger

(2) Batteries

(i) A separate automatic and manually operated bypass switch and all necessary hardware and interconnect wiring.

(ii) The UPS shall be capable of providing power for full run-time operation for an LED-only intersection (all colors: red, yellow, green, and pedestrian heads) or flashing mode operation and intersection red LEDs.

(iii) The UPS shall be designed for outdoor applications.

(3) Enclosure

(i) The UPS enclosure shall be capable of being both side mounted and ground mounted.

(ii) The enclosure will house the batteries, UPS, and bypass switches. The cabinet must meet the requirements for NEMA 3R enclosures. The housing dimensions must be such that the housing may be easily attached to the side of an M or P type cabinet.

(iii) The enclosure dimensions shall not exceed 50 inches high by 17 inches wide by 17 inches deep.

(iv) The UPS enclosure must not interfere with the opening of the traffic cabinet door. The complete enclosure and door must be made from 0.125-inch-thick aluminum. All external seams must be continuously welded.

(v) The cabinet must have a door to access the complete cabinet interior. The door must have a three-point locking mechanism with rollers at the ends for the latch rods. The key lock must be a Corbin cylinder lock with a #2 key. When the door is opened, it must have stops at 90 and 130 degrees. A continuous neoprene gasket must be used to weatherproof the enclosure when the door is closed.

(vi) A fan must be mounted in the air baffle at the top of the cabinet with an air outlet built into the overhang. The fan must be thermostatically controlled. The bottom of the door must be louvered to allow airflow. A removable dust filter must be located behind the vent.

- (vii) The entire enclosure must be powder-coated black aluminum.
 - (viii) When the UPS is mounted into the enclosure, it must be mounted to accommodate straight-on horizontal viewing of the liquid crystal display (LCD) screen on the UPS.
 - (ix) The enclosure shall include a flush-mounted generator compartment with neoprene gaskets for weatherproofing. The generator compartment shall include a locking 30-amp plug, L5-30P, for connecting a portable AC generator. A manual transfer switch shall be mounted within the generator compartment to allow transferring from utility power to generator power. The generator door will have a cable slot to allow the door to be closed when the generator is plugged in and the cable to be locked inside the compartment. The door will include a Corbin Type 2 lock.
- (4) Battery system
- (i) Individual batteries shall be as follows:
 - (A) Voltage rating: 12V type
 - (B) Amp-hour rating: 100 amp-hours minimum
 - (C) Group size: 31 minimum
 - (ii) Batteries shall be easy to replace and available commercially off the shelf.
 - (iii) UPS assemblies shall consist of four to eight batteries. All batteries must meet specifications out of the box immediately after the initial 24-hour top-off charge. Batteries that require cycling to meet the amp-hour rating specifications are not acceptable.
 - (iv) Batteries shall be deep discharge, sealed prismatic lead-calcium-based, gelled electrolyte/valve-regulated lead acid. Batteries designed for cycle applications, such as solar, are not acceptable. Batteries must be designed for standby applications.
 - (v) Batteries shall be certified by the manufacturer to operate over a temperature range of -25 to $+74^{\circ}\text{C}$.
 - (vi) The batteries shall be provided with appropriate interconnect wiring and corrosion-resistant mounting trays, shelves, and/or brackets appropriate for the cabinet into which they will be installed.
 - (vii) Batteries shall indicate maximum recharge data and recharging cycles.
 - (viii) Battery interconnect wiring shall be via two-part modular harness.

- (A) Part I shall be equipped with red (+) and black (-) 30.48 cm (12-inch) cabling that can be permanently connected to the positive and negative posts of each battery. Each red and black pair shall be terminated into an Anderson-style power pole connector or equivalent.
- (B) Part II shall be equipped with the mating power pole style connector for the batteries and a single, insulated power pole style connection to the inverter/charger unit. The harness shall be fully insulated and constructed to allow batteries to be quickly and easily connected in any order to ensure proper polarity and circuit configuration.
- (ix) Power pole connectors may be one- or two-piece. If a two-piece connector is used, a locking pin shall be used to prevent the connectors from separating.
- (x) All battery interconnect harness wiring shall be UL Style 1015 Canadian Standards Association (CSA) thermoplastic equipment wire or welding-style cable or equivalent, all of proper gauge with respect to design current and with sufficient strand count for flexibility and ease of handling.
- (xi) Battery terminals shall be covered and insulated with molded boots to prevent accidental shorting.
- (xii) A battery balancer shall be provided that automatically balances the battery's charging voltage on all batteries in the string to within $\pm 60\text{mV}$ between any two batteries. The balancer shall allow any single 12V battery within the battery string to be replaced at any time during the warranty period and not require the purchase of new batteries.

2 UPS Operation

- (a) The UPS shall provide a minimum of 6 hours of full run-time operation with an additional 2 to 4 hours of red flash operation for an LED-only intersection, with a maximum 800W active output load capacity. The inverter, when on batteries, shall operate with a minimum efficiency of 84% with a load from 25% to 90% of the UPS total output rating. The UPS shall operate at 97% or higher when operating under normal conditions (i.e., utility power is available).
- (b) For safety and efficiency, the UPS shall operate with a nominal 48VDC bus. A DC level higher than 56VDC shall be considered unsafe and not acceptable.
- (c) The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 5 milliseconds. A 5-millisecond maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.
- (d) The UPS shall include a rack-mounted Fail Safe Automatic/Manual Transfer Switch (FS-ATS) for bypassing the UPS for maintenance. The FS-ATS will be a three-stage

configuration: UPS normal mode, bypass UPS on, and bypass UPS off. The FS-ATS shall be mounted on a 19-inch rack inside the UPS side-mount enclosure.

- (e) The BBS shall have six sets of normally open (NO) and normally closed (NC) single-pole double-throw, individually programmable, dry-relay contact closures, available on a front panel-mounted terminal block. These contact closures shall be rated at a minimum of 120V/1A and labeled so each contact can be identified.
- (f) One set of NO and NC contact closures shall be energized when the unit switches to battery power. Contact shall be labeled or marked "On Batt."
- (g) A second and third set of NO and NC contact closures shall be energized whenever the battery approaches approximately 40% of remaining useful capacity. Contact shall be labeled or marked "Low Batt." This setting must be adjustable from 10 to 90% via the RS-232 connection.
- (h) A fourth set of NO and NC contact closures shall be energized 2 hours after the unit switches to battery power. Contact shall be labeled or marked "Timer." This setting must be adjustable from 1 minute to 8 hours via the RS-232 connection.
- (i) A fifth set of NO and NC contact closures shall be energized in the event an alarm condition occurs. Contact shall be labeled "Alarm."
- (j) A 48VDC output shall be provided for operating an external fan. The output can also be factory configured as a dry contact.
- (k) Relay contact activation shall be annunciated on the front panel via a visual indication. The indication can be a discrete LED or part of the LCD screen.
- (l) The BBS shall have two timers, independently programmable from 0 to 8 hours with two times-of-day restrictions on each timer, with dry contacts to activate red flash operation at user-definable times of day.
- (m) The BBS shall allow three user inputs to support Intrusion Alarm, Emergency Power Off, and external self test (battery test).
- (n) Operating temperature for both the inverter/charger and manual bypass switch shall be -37 to $+74^{\circ}\text{C}$ with a load of 850W.
- (o) The FS-ATS shall be rated at 240VAC/30 amps, minimum.
- (p) The BBS shall use a temperature-compensated battery charging system. The charging system shall compensate over a range of 2.5 to 6.0mV / $^{\circ}\text{C}$ per cell. The temperature sensor shall be external to the inverter/charger unit. The temperature sensor shall come with 3 meters (9 feet and 10 inches) of wire.
- (q) Batteries shall not be recharged when battery temperature exceeds $50^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- (r) The BBS shall bypass the utility line power whenever the utility line voltage is outside the voltage range of 85VAC to 175VAC ($\pm 2\text{VAC}$). During a utility input from 85VAC to 175VAC, the UPS shall use its internal double-buck, double-boost regulation to

maintain a 108VAC to 131VAC output to the controller cabinet without the use of the batteries. The BBS shall go into Boost Mode 1 when the AC line voltage drops below 110VAC, ± 2 VAC. When the AC line drops below 96VAC, ± 2 VAC, the BBS shall go into Boost Mode 2. When the AC line voltage reaches 131VAC, ± 2 VAC the BBS shall go into Buck Mode 1. When the AC line voltage reaches 150VAC, the BBS shall go into Boost Mode 2.

- (s) When using battery power, the BBS output voltage shall be between 110VAC and 128VAC, pure sine wave output, $\leq 3\%$ THD, $60\text{Hz} \pm 3\text{Hz}$.
- (t) The BBS shall be compatible with NEMA 170 or 2170 controllers and cabinet components for full-time operation. All loads to the maximum rating of the BBS shall be powered through the BBS system to use the UPS internal buck/boost regulation.
- (u) In cases of low (below 85VAC) or absent utility line power, when the utility line power has been restored to normal for more than 3 seconds, the BBS shall transfer from the boost regulation mode or the battery-backed inverter mode back to utility line mode.
- (v) In cases of high utility line power (above 175VAC), when the utility line power has been restored to normal for more than 3 seconds, the BBS shall transfer from the buck regulation mode or battery-backed inverter mode back to utility line mode.
- (w) The BBS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service. For conformation, the UPS module must be UL/CSA approved and labeled. "Tested to" or "Built to" UL/CSA is not acceptable.
- (x) In the event of inverter/charger failure, battery failure, or complete battery discharge, the FS-ATS shall revert to the NC (and de-energized) state if utility line power or generator power is available and connected to the cabinet.
- (y) Recharge time for the battery, from "protective low-cutoff" to 90% or more of full battery charge capacity, shall not exceed 8 hours, unless limited by the temperature-regulated charger due to excessive battery heat that could damage the integrity of the battery string.
- (z) Batteries shall be deep discharge gel-type valve-regulated lead acid batteries and compatible with the battery charger.

3 Maintenance, Displays, Controls, and Diagnostics

- (a) The BBS shall include a display and/or meter to indicate current battery charge status and conditions.
- (b) The BBS shall have voltmeter standard probe input jacks (+) and (-) to read the exact battery voltage drop at the inverter input.

- (c) The BBS shall have lightning surge protection compliant with ANSI/IEEE C.62.41, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits.
- (d) The BBS shall be equipped with an integral system to prevent batteries from destructive discharges and overcharges.
- (e) The BBS and batteries shall be easily replaced with all needed hardware and shall not require any special tools for installation.
- (f) The BBS shall display via an LCD panel the number of times the BBS was activated and the total number of hours the unit has operated on battery power. The LCD display shall show the UPS mode, alarm status, input and output voltages, output current, battery voltage, battery charger current, and last event. It shall allow the battery charger to be programmed from 3-, 6-, and 10-amp charger settings.
- (g) The BBS shall include two separate communication ports on the front panel of the UPS, a factory-installed internal Ethernet port for Simple Network Management Protocol / Web communications, along with an RS-232 port for local communications.
- (h) The BBS shall include a Microsoft Windows Graphical User Interface for programming and monitoring the BBS. The interface must be provided in addition to HyperTerminal at no cost.
- (i) The manufacturer shall include a set of operation manuals and wiring diagrams of the BBS with each BBS. Two sets of maintenance manuals, an equipment list, and the battery data sheets shall be provided upon request for evaluation purposes.

4 Execution

- (a) Production quality control tests shall be performed on each new system prior to shipment. Failure to meet these requirements shall be cause for rejection. Each system shall be visually inspected for any exterior physical damage or assembly anomalies. Any defects shall be cause for rejection.
- (b) The auxiliary cabinet will be mounted to the traffic control cabinet with six hex-head bolts, 1/4 inch by 20 inches. All holes will be field drilled by the Contractor to accommodate the situation. A grommet must be supplied to protect the cable in a field-drilled 1.5- to 2-inch hole for cable connection to the existing traffic controller. The Contractor will supply all the mounting hardware, bolts, washers, nuts, gaskets, bushings, grommets, caulking, and similar items necessary to install the cabinet in a safe and weatherproof manner.
- (c) The Contractor shall confirm, prior to drilling into existing cabinet, that the UPS will not interfere with access to the cabinet, or present a clearance issue by blocking sidewalk or curb ramps.
- (d) The Contractor shall test UPS operation prior to scheduling inspections.

5 **Warranty**

- (a) Manufacturers shall provide a 2-year factory-repair warranty for parts and the Contractor shall transfer the warranty to the County upon acceptance.
- (b) Batteries shall be warranted for full replacement for 4 years from date of purchase with an additional 1 year added when a battery balancer is installed at time of initial installation. A battery shall be considered bad if it does not deliver 80% of its original capability within the warranty period.

6 **Measurement and Payment**

- (a) ***Furnish UPS System*** shall be measured and paid for per each. The UPS System cost shall include the complete UPS unit, battery package, auxiliary cabinet, switching device, all batteries and harnesses, and all other incidentals required for installation.
- (b) ***Install UPS System*** shall be measured and paid for per each. Installation shall include all materials, labor, equipment, and all other incidentals necessary to field mount the auxiliary cabinet, make all necessary connections, install, and test the battery backup system.

Section 13175: Traffic Signal Turn-On, Pickup, Removal, and Maintenance

1 General Description

- (a) Traffic signal turn-on, pickup, removal, and maintenance shall consist of picking up County-furnished materials, removing existing equipment, and maintaining existing equipment as specified in the Contract.

2 Execution

(a) Equipment turn-on

- (1) Notify the Engineer and Arlington County representatives within 10 working days prior to completion of the project to allow the County to install any additional traffic control devices such as markings and signage.
- (2) Notify the Engineer and Arlington County representative 5 working days prior to the completion of the project to schedule a final inspection and turn-on.

(b) Pick-up of County-furnished materials

- (1) Notify the appropriate members of Arlington County a minimum of 72 hours before the anticipated pick-up of materials furnished by the County.
- (2) The Contractor shall be responsible for the transportation, labor, equipment, tools, and incidentals necessary to obtain and load any County-furnished materials.

(c) Removing and disposing of existing traffic signal material and equipment

- (1) Concrete foundations that are designated to be removed shall be removed to a depth of 12 inches below grade. All holes left by the removal shall be backfilled, compacted, and restored to surrounding conditions.
- (2) All existing hard rubber detectors and handholes not shown on the plans to remain shall be removed. The holes shall be backfilled, compacted, and restored to surrounding conditions. The sidewalk where handholes are removed shall be reconstructed to the nearest tooled joint or expansion joint. The roadway where hard rubber detectors are removed shall be reconstructed in conformance with Arlington County utility patch repair standards.
- (3) The Contractor shall disconnect existing inductive loop detectors and magnetic detectors not shown on the design plans to remain.
- (4) Non-galvanized green painted structures may contain lead. The Contractor is responsible for the proper disposal of such material.

(d) Storage of materials

Materials shall be bundled, stored, and protected in conformance with the manufacturer's recommendations or as approved by the Engineer.

(e) Maintenance of materials and equipment

- (1) Arlington County will continue maintaining any existing signals until the Contractor places new equipment into operation.
- (2) When the work requires adjustments to the traffic control devices to maintain the minimum County standards, the adjustments to the traffic control devices shall be made within 4 hours of verbal notification by the Engineer. Failure to comply with this period will result in the County's performing adjustment and deducting the cost of the adjustment from the Contractor's payment.
- (3) Existing signals shall remain in their original condition until the new signals have been completed, satisfactorily tested, and their operation accepted by the Engineer.
- (4) The Contractor shall maintain the continuous operation of all vehicular and pedestrian detectors. If any detector is damaged by the Contractor, it shall be repaired within 72 hours after notification by the Engineer.
- (5) All traffic signals and existing interconnect cable shall be operational and actuated as specified in the contract.
- (6) The Contractor shall plan the work to minimize interference with any existing traffic control device.

3 Measurement and Payment

- (a) Equipment turn-on will not be measured, but the cost will be incidental to other pertinent items specified in the contract.
- (b) Pick-up of County-furnished materials will not be measured, but the cost will be incidental to other pertinent items specified in the contract.
- (c) Materials storage, cable sealing and handling, adjustments to maintain minimum County standards on existing signals made necessary by new signal or geometric modifications, and Contractor repair of any damaged detector caused as a result of the Contractor's error will not be measured, but the cost will be incidental to other pertinent items specified in the contract.
- (d) ***Remove, Dispose, and Salvage Existing Signal*** will be measured and paid for on a lump sum basis.

Section 13176: Signal Design

1 Design Elements

- (a) All signals shall be designed to meet the following minimum requirements unless directed by Arlington County:
- (1) Signal poles must be located in all quadrants of the intersection
 - (2) Signals must have detection for all signal phases
 - (3) LED signal heads are required
 - (4) LED pedestrian signals with Polara-style APS pushbuttons are required in all quadrants
 - (5) Americans with Disabilities Act (ADA)-compliant curb ramps are required in all quadrants of the intersection
 - (6) EVP devices are required for all approaches
 - (7) One CCTV is required per intersection; multiple locations may be requested depending on complexity of intersection
 - (8) Signal communication must be interconnected
 - (9) Battery back-up is required
 - (10) All cabinets must be Size P, Type TS2
 - (11) Street name signs should be mounted close to mast arm poles
 - (12) The signal junction box directly adjacent to the cabinet shall be large size in accordance with standard 61-04.

2 Plan Development

- (a) Traffic signal plans shall be prepared on 1 inch = 25 feet scale CADD base sheet and include all design elements as well as the following information unless directed by Arlington County:
- (1) Existing and proposed signal equipment
 - (2) NEMA signal phasing
 - (3) Detectors
 - (4) Conduits
 - (5) Junction boxes
 - (6) Signal poles
 - (7) Signal heads
 - (8) Controller cabinet

- (9) Pedestrian facilities
 - (10) Signing
 - (11) Pavement markings
 - (12) Lighting
 - (13) Construction notes
 - (14) Location of existing and proposed power source
 - (15) Location of existing and proposed underground and overhead utilities
 - (16) Geometric improvements
 - (17) Existing and proposed Right-of-way and easements
 - (18) Traffic signal timing information
 - (19) Fiber optic splice diagram (if needed)
 - (20) Required plan sheets and contents for stand-alone traffic signal plans
- (b) All Arlington County signal plans must contain the plan sheets listed in Table 17-1 and the described contents at a minimum. For signal plans in which existing communications are to be maintained, the communications plan may be omitted. For signal plans submitted as part of a larger plan set, the format of the required contents may be modified.

Table 76-1: Minimum Requirements for Signal Design Plan Sheets

| Plan Sheet | Minimum Requirements |
|--|---|
| Coversheet | <ul style="list-style-type: none"> • Arlington County general traffic signal construction notes • Location map • Table of contents |
| Traffic Signal Plan (Traffic Signal Modification Plan) | <ul style="list-style-type: none"> • Proposed and existing signal equipment⁽¹⁾ • Proposed and existing signs** • Phasing diagram⁽¹⁾ • Conduit schedule • Legend** • Proposed markings (screened)⁽¹⁾ • Pole schedule (include Part No. for Arlington Funded signals) • Pedestrian pushbutton detail • Construction notes • Timing chart • Enlarged insets where needed to show detail⁽¹⁾ • Pole location detail⁽¹⁾ • Bolt circle diagram • Boring locations |

| Plan Sheet | Minimum Requirements |
|----------------------------|---|
| Pavement Marking Plan | <ul style="list-style-type: none"> • Existing pavement markings (to remain or be eradicated)⁽¹⁾ • Proposed pavement markings including stop bars, crosswalks, and lane arrows⁽¹⁾ • Dimensions for lane widths and marking spacing • Parking and bicycle markings as needed⁽¹⁾ • Required width, type, and color for proposed markings |
| Signal Communications Plan | <ul style="list-style-type: none"> • Existing communications layout • Proposed communications layout • Fiber optic splice diagram (provided by County if needed) |
| Summary of Quantities | <ul style="list-style-type: none"> • Existing items to be removed • Existing items to be salvaged • Proposed items to be installed |

⁽¹⁾ Included in 30% submittal. All other items should be provided in subsequent submittals.

Section 13177: Preventive Maintenance

1 Materials

All materials furnished as part of preventive maintenance shall be provided by the Contractor. Materials include, but are not limited to, cabinet air filters, ties, labels, and fasteners.

2 Execution

(a) Cabinet preventive maintenance

- (1) Preventive cabinet maintenance is completed annually by the County to ensure good working order of the existing cabinets.
- (2) Preventive maintenance shall include cleaning of the cabinet interior and testing/checking of various equipment within the cabinet including controller, BIUs, load switches, power supply, fans, fuses, breakers, flashers, and similar equipment. The Contractor shall seal the cabinet base and conduit ends, shop- and field-test the monitor, lubricate the various gaskets and hinges, replace the filter, test the loops and other detection elements including push-buttons, and test the grounding system. A checklist will be provided by the County Project Manager.

(b) Overhead preventive maintenance

- (1) Overhead preventive maintenance is completed biannually by the County to ensure good working order of overhead facilities.
- (2) Overhead preventive maintenance shall include cleaning lenses, visual inspection of signal indications (securing/straightening heads as instructed by the Trades Program Supervisor [TPS]), cables, hangers, poles (e.g., painting, bolts, covers, grouts), mast arms, span wires, and tie/helical wraps.
- (3) The Contractor is responsible for coordinating all required traffic control in accordance with VDOT and County standards.

(c) School Beacon Preventative Maintenance

- (1) School Beacon preventative maintenance shall include the re-adjustment of solar panels, cleaning of solar panels, replacement of battery for solar installations, ensuring wiring and signage is in good working condition, and verifying serial numbers of the control unit.

(d) Replace Existing Cabinet in Place

- (1) Replacing a cabinet in place involves replacing a faulty cabinet by removing the existing cabinet and replacing it on the same foundation.
- (2) The Contractor shall tag and label all cables prior to disconnection.

- (3) If the foundation requires extension, the extension shall be completed prior to disconnection.
- (4) The Contractor shall ensure that the replacement cabinet is wired as completely as possible prior to the disconnection of the existing cabinet in order to minimize downtime.
- (5) The Contractor shall fully wire and reconnect all equipment in the replacement cabinet per “Set Cabinet” specification.

3 Measurement and Payment

- (a) **Cabinet Preventive Maintenance** shall be measured and paid for per each. Cabinet preventive maintenance shall be billed at the unit rate regardless of number of technicians or complexity of maintenance of traffic activities. Materials used in cabinet preventive maintenance activities such as air filters, ties, and fasteners shall be considered incidental.
- (b) **Overhead Preventive Maintenance** shall be measured and paid for per each. Large intersections may be billed at a higher rate than small intersections at the County’s discretion. A “large” intersection shall be an intersection with more than 4 mast arms or more than 9 overhead vehicular signals. Materials used in overhead preventative maintenance activities such as ties and fasteners shall be considered incidental.
- (c) **School Beacon Preventative Maintenance** shall be measured and paid for per each. Cost shall include cleaning supplies, bolts or nuts used to adjust the solar panels, any required wiring, and disposal of batteries.
- (d) **Replace Cabinet in Place** shall be measured and paid for per each. Cost shall include labor, wires, ties, bolts, etc. required to remove the existing cabinet and install the new cabinet.
- (e) The replacement of LED lamps shall not be included in the payment for overhead maintenance. Replacement of LED lamps shall be approved by the County Project Officer prior to execution.

Section 13178: Loop Detectors

1 Materials

The Contractor shall supply all necessary materials to complete the job including the following items:

- (a) Loop wire shall have cross-linked polyethylene insulation. Loop wire shall be #14 AWG and shall meet the IMSA 51-5 specification.
- (b) Detector lead-in cable shall be stranded copper, twisted pair, #14 AWG conforming to the requirements of the IMSA 50-2 specification.
- (c) Cables shall be #14 AWG copper conforming to the requirements of IMSA 19-1 or 20-1.
- (d) Loop sealant shall be Bondo #606 or equivalent.

2 Execution

- (a) Installation of loop detector stub-out
 - (1) The loop detector stub-out shall be the conduit extending from the small junction box behind the curb to the gutter pan.
 - (2) Two 1-inch rigid, galvanized steel conduits shall be installed for each stub-out.
 - (3) The conduit shall enter the junction box 18 to 24 inches below grade.
 - (4) Conduit shall be drilled through the curb and gutter and shall be stubbed up into the gutter with a 90-degree conduit elbow.
 - (5) The hole in the gutter shall be filled with a 1-inch layer of duct seal.
- (b) Installation of loop detectors
 - (1) All loops shall have a minimum of three turns of wire unless otherwise noted by the Engineer or authorized representative.
 - (2) Loops shall be wired in a clockwise direction.
 - (3) Loop lead-in wire in saw cuts shall be twisted more than three turns per foot. Twisting shall be verified by the Engineer or the authorized representative prior to applying sealant to the saw cut.
 - (4) The Contractor shall saw-cut the roadway using a diamond or abrasive blade saw. Saw cuts shall be cleaned with pressurized water at a minimum of 50psi and then dried with filtered compressed air before loop conductors are installed. The saw cut shall be wide enough to allow full encapsulation of the loop wires by the sealant. The saw-cut slot shall be a minimum of 3 inches deep except in areas where a concrete roadway overlaid with asphalt is encountered. If asphalt

overlay on a concrete roadway is encountered, the Engineer or the authorized representative will determine if additional depth is required.

- (5) Where a loop detector or lead-in must cross an expansion joint, the Contractor shall drill a 2-inch-diameter hole with a depth equal to the saw cut. Slack shall be provided in the loop wire inside the hole to allow for pavement movement. The wire in the hole shall be encapsulated with loop sealant.
- (6) All corners where loop wires turn shall be rounded smooth so there are no jagged edges or protrusions that could damage the wire. Loop corners must be cored, chiseled, beveled, or diagonally cut to eliminate sharp edges.
- (7) The sealant (#606 Bondo or equivalent) shall be applied so the wires in the saw cut are completely surrounded with the sealant and there are no voids in the sealant.
- (8) The sealant shall be applied into the saw cut under pressure with a nozzle that allows the sealant to flow directly into the saw cut. Pouring the sealant into the saw cut is not acceptable. There shall be no sealant on the roadway surface.
- (9) All loops shall be tested in the presence of the Engineer or the authorized representative before sealant is added. Loop resistance shall be less than 5 ohms, and loop resistance to ground shall be greater than 100 megohm.
- (10) Home-run cables shall be shielded and waterproofed. Home-run cable shields shall not be connected to earth ground—only insulated and floating on both ends.
- (11) Approved splices shall be soldered, insulated, and waterproofed. The solder shall be rosin core solder. Splices shall only be allowed in handholes and pull boxes. A separate splice kit shall be used for each lead-in cable. Splice kits used for splicing shall be Direct Bury Underground rated.
- (12) The Contractor shall provide appropriate pollution control measures during construction of the loops. Slurry from work shall not be permitted to enter the storm sewers or surface waters per County regulations.

3 Measurement and Payment

- (a) ***Install Loop Detector Stub Out*** shall be measured and paid for per each.
- (b) ***Install Loop Detector*** shall be measured and paid for per linear foot.
- (c) ***Splice Loop and Terminate in Cabinet*** shall be measured and paid for per each loop spliced.
- (d) Cost for required proper erosion control and stormwater pollution prevention measures shall be incidental to items listed in this specification.

Section 13179: Thermal Video Detection Cameras

1 Materials

- (a) Thermal traffic cameras shall be forward-looking infrared (FLIR) FC-Series model FC-334T, FC-348T, FC-324T, or approved equivalent.
- (b) Communication boards shall be FLIR brand ViewCom/E MAX+ or approved equivalent.
- (c) Thermal traffic cameras shall not depend on any visible or invisible (infrared) illumination or image intensifier to function (i.e., produce images). Thermal traffic cameras shall be totally passive and not produce any energy or emit light any bandwidth. Thermal traffic cameras shall allow the user to clearly identify images in the total absence of light.
- (d) Thermal traffic cameras shall feature both white-hot and black-hot operating modes. In the white-hot mode (default), warmer objects are displayed in white and lighter shades than cooler or background areas. In the black-hot mode, warmer images are displayed as black or dark gray compared to cooler background objects.
- (e) Thermal traffic cameras shall provide standard NTSC or Phase Alternating Line analog composite video output factory-configured to allow them to function as direct replacements for daylight cameras, and to connect directly to industry standard video detection software cards and recording devices. The analog video signal shall be available via both a Bayonet Neill–Concelman video output connector and a connector free terminal block. The video outputs shall be surge protected.
- (f) Thermal traffic cameras shall be furnished in an IP-66-rated outdoor enclosure with sunshield and mounting base. The mounting base shall be provided with 1/4-inch by 20-inch holes for mounting to a pedestal or wall mount. All cable connections shall be made inside of the enclosure. The enclosure shall be provided with liquid-tight sealed cable gland fittings for the video and power cables.
- (g) Camera enclosures shall include grounding and surge protection. A separate earth-ground connection shall be made inside the enclosure to a designated grounding lug. The earth-ground conductor may be part of the power cable bundle.
- (h) Thermal traffic cameras shall operate on surge-protected 110/220VAC.

2 Warranty

- (a) The supplier shall provide a limited 2-year warranty on the thermal traffic detection camera.
- (b) The thermal detector in the thermal traffic camera core shall have a 10-year warranty.

- (c) The Contractor shall supply copies of all warranties to the County prior to final acceptance.

3 Execution

- (a) Installation of thermal camera shall include:
 - (1) Mounting the camera on mast arm or pole.
 - (2) Pulling the video detector lead-in cable back to the cabinet.
 - (3) Terminating the cables into the appropriate detection rack including all connectors and hardware required to make the connections.
 - (4) Configuring the detection zones and verifying that the output is mapped to the correct phase on the controller.
 - (5) Testing the detection to ensure that the zones are configured to correctly detect vehicles.
- (b) Installation of video detection communication board shall include:
 - (1) Installation of the ViewCom/E MAX+ board into the cabinet along with all required connections (connection to switch as well).
 - (2) Verification with County staff at Traffic Management Center that the board is correctly relaying video feeds to the central system.
- (c) Installation of Thermal Camera System shall include:
 - (1) Installation of all required thermal cameras as called for in the design plans as well as the installation of video detection communication board (per part a and b of this section). This item includes the installation and termination of all required lead-in cables.
- (d) Integrate Video Detection System shall include:
 - (1) Installation of the detector rack and cards as needed as well as the communications board.
 - (2) Calibration of the detection zones and adjustment of the cameras if needed
 - (3) Connecting video detection communications board to the cabinet switch and enabling communications.

4 Measurement and Payment

- (a) **Furnish Thermal Camera** shall be measured and paid for at the contract unit price and shall include all associated equipment required for proper installation including mounting bracket.
- (b) **Furnish Thermal Camera Lead-in Cable** shall be measured and paid for at the contract unit price per linear foot.

- (c) ***Install Video Detection Communication Board*** shall be measured and paid for at the contract unit price per each.
- (d) ***Install Video Detection Camera*** shall be measured and paid for at the contract unit price per each.
- (e) ***Install Thermal Camera Lead-in Cable*** shall be measured and paid for at the contract unit price per linear foot.
- (f) ***Furnish and Install Thermal Camera System*** shall be measured and paid for on a lump sum basis.
- (g) ***Integrate Video Detection System*** shall be measured and paid for on a lump sum basis.

Section 13180: Electric Signal Service

1 County Standards

The detail drawings in the Arlington County Traffic Signal Standards that are applicable to the Electric Signal Service are as follows:

- (a) 80-01 Electric Signal Service

2 Materials

- (a) Meter pedestals shall be Midwest Electric Products, Inc. Model R281C1P6Hpr R208CP6HP (200 AMP main breaker and 5th jaw).
- (b) Load side wire shall meet standards of electric service cables in Section 13165.
- (c) Conduit used shall be 2" rigid metallic conduit with grounding wire per Section 13165 and 13164.

3 Execution

- (a) Installation of meter pan and pedestal shall include:
 - (1) Installing the meter pedestal and pan, connecting the load side conduit and providing all required wiring and breakers. This includes installation of the concrete foundation and the excavation required.
 - (2) Depending on the installation, the Contractor may be required to install a disconnect box and photocell as well.
 - (3) Installation of ground rods and grounding wire. Grounding shall be per IMSA requirements, VDOT standards, and the schematic detail containing in Arlington County Standard 80-01.
 - (4) The Contractor shall coordinate energization and installation of the meter with Virginia Dominion Power and the County's Construction Manager. The Contractor shall perform testing of the load side using a generator, prior to de-energizing any existing service or activating a new service.
 - (5) The Contractor is responsible for coordination and cost of police traffic control if needed.
- (b) Removal of meter pan and pedestal shall include:
 - (1) Coordination of de-energizing the existing service with power company.
 - (2) Demolition of the meter pan, pedestal, conduits, and cables.

4 Measurement and Payment

- (a) ***Furnish and Install Meter Pan and Pedestal*** shall be measured and paid for per each and shall include the cost of restoration.

(b) ***Remove Meter Pedestal and Pan*** shall be measured and paid for per each.

Section 13181: Aerial Work

1 Materials

- (a) Wood Poles shall be Class IV, pressure treated, R. E. A. specification, 40-foot wood poles designed specifically for overhead electrical utility use.
- (b) Down Guys shall be 3/8 inch, galvanized steel, Seimens-Martin grade guy strand.
- (c) Guy guards shall be white, PVC, permanently attached to the guy line to provide protection from the line.
- (d) Guy anchors shall be 8 way bust anchors with 5/8" x 7 foot galvanized anchor rod.
- (e) Lashing rods shall be made of the same material as the messenger they are lashed to.
- (f) Risers shall be 2" rigid metallic conduit unless directed otherwise.
- (g) All materials shall comply with VDOT Road and Bridge Specifications Section 238.

2 Execution

(a) Guys

- (1) Down Guys shall be attached at the top of the pole with a 5/8 inch galvanized guy bolt and washers. The guy strand shall be attached to the guy bolt and the guy anchor by use of appropriate galvanized line hardware.
- (2) Sidewalk guy type shall include the installation of pipe of the appropriate length and additional fittings.
- (3) Bust type guy anchors shall be driven into augured holes and placed as directed by the Engineer or the authorized representative; so as to develop the full strength required to offset the load placed on the pole.
- (4) Removal of down guy shall include removal of the anchors, guy wires, pipes, and associated hardware.

(b) Wood pole

- (1) Specification shall be approved by TE&O before they are installed. Typically, the wood poles shall be installed by auguring a six-foot hole, minimum, placing the pole and back-filling with select material to an adequate compaction to support the pole. Buried depth of pole may be required up to 10'.
- (2) Removal of wood pole shall include removal of the wood pole from the site and disposal of the pole by the Contractor. The resulting hole shall not remain open at the end of the workday: the hole remaining shall be back-filled with select material and compacted to a density of 95% and patched with cold mix asphalt or permanently restored.

(c) Straighten span cable shall include straightening twisted signal heads or other hanging assemblies and retying loose overhead cable by attaching to span. This shall include tensioning the span if needed.

(d) Risers

(1) Installation of riser shall include a conduit stub out at the base of the pole as well as a weatherhead at the top of the riser.

(2) Contractor shall ensure adequate clearances for weatherhead height and coordinate any required relocations with the pole owner.

(3) U-guard shall only be permitted for risers with communications cable.

(e) Aerial Cable and Messengers

(1) Aerial cable installation shall include the lashing of cable to messenger strand, storage reels, and slack storage loops as directed by the plans or as directed by the County engineer.

(2) Installation of messenger span shall include the installation of all attachment hardware.

(3) Contractor shall maintain tension during pulling process by using an approved mechanical clutch device. Contractor shall not allow the cable to contact the ground or other obstructions during installation.

(4) Contractor shall label all attachments with approved label.

(f) Overhead Installation

(1) Installation of signs on spanwire shall include the fastening of a sign on spanwire. Saddle bracket shall be furnished and installed by the Contractor.

(2) Installation of traffic signals on spanwire shall include the fastening of a signal onto the spanwire. The Contractor shall lash signal cable to span wire and make necessary terminations in the cabinet. The lashing rods and signal mounting hardware shall be furnished by the Contractor.

3 Measurement and Payment

(a) **Install Aerial Cable** shall be measured and paid for on a linear foot basis.

(b) **Straighten Overhead Span Cable Pan** shall be measured and paid for per each.

(c) **Furnish and Install Down Guy** shall be measured and paid for per each.

(d) **Furnish and Install Sidewalk Guy** shall be measured and paid for per each.

(e) **Furnish and Install 2" Riser** shall be measured and paid for per each and shall include the cost of installing the weatherhead, and stub out at the base of the pole.

(f) **Install Cable with Lashing Rods on Messenger** shall be measured and paid for on a linear foot basis.

- (g) **Furnish and Install Steel Messenger Span with Lashing Rods** shall be measured and paid for on a linear foot basis. Cost of attachment hardware shall be incidental.
- (h) **Install Cable with Lashing Rods on Messenger** shall be measured and paid for on a linear foot basis.
- (i) **Furnish and Install Wood Pole** shall be measured and paid for per each.
- (j) **Remove Wood Pole** shall be measured and paid for per each.
- (k) **Furnish and Install Strain Pole** shall be measured and paid for per each.
- (l) **Remove Strain Pole** shall be measured and paid for per each.
- (m) **Install Signal Head on Span Wire** shall be measured and paid for per each. The lashing and mounting hardware shall be incidental.
- (n) **Install Sign on Span Wire** shall be measured and paid for per each. The mounting hardware shall be incidental.
- (o) **Remove Messenger** shall be measured and paid for per linear foot.
- (p) **Remove Aerial Cable** shall be measured and paid for per linear foot and shall include the unlashings of aerial cable and disposal of the cable. The removal of all attachment hardware and any messenger span shall be incidental.

Section 13182: Vehicle Signals

1 Materials

- (a) Generally, all vehicle signal heads and mounting equipment shall conform to VDOT Road and Bridge Specifications, latest edition.
- (b) Where required, backplates shall have retroreflective borders per latest FHWA and VDOT guidance and retroreflective material shall be pre-applied in the case of a new backplate.

2 Execution

(a) Signal Heads

(1) Assemble and Install

- (i) Contractor shall assemble signal housing and LED modules into desired configuration.
- (ii) Contractor shall secure LED modules with quick-release clips unless directed otherwise by the Traffic Engineer.
- (iii) The Contractor shall mount the signal using mounting hardware approved by the County onto the mast arm.
- (iv) The Contractor shall ensure the visibility of the signals is adequate for traffic.
- (v) In the case of a new signal head, the Contractor shall bag the head and test the operation prior to activation.
- (vi) Installation of programmable heads shall include the programming of the lens with masking kit or as directed by the manufacturer.

(2) Remove Signal Head

- (i) Contractor shall remove the head and mounting hardware, disconnecting all cables from the cabinet, and removing the cable from the pole and arm. Contractor shall provide and install rubber grommets for any resulting unused holes in the mast arm.

(b) Louvre

- (1) Installation shall include the mounting of the louvres on the signal lense and verifying proper visibility. Contractor shall adjust louvres if directed by County upon inspection.
- (2) Removal shall include unmounting the louvre from the head as directed.

(c) Install Backplate

- (1) Contractor shall install backplate on existing signals as directed.
- (d) LED Blank Out Signs
 - (1) Installation of a blank out sign shall include mounting the sign, and making all necessary terminations in the cabinet or control box.

3 Measurement and Payment

- (a) **Assemble and Install Signal Head** shall be measured and paid for per each.
- (b) **Remove Signal Head** shall be measured and paid for per each.
- (c) **Assemble and Install Programmable Signal Head** shall be measured and paid for per each.
- (d) **Remove Programmable Signal Head** shall be measured and paid for per each.
- (e) **Assemble and Install LED Blank-out Sign** shall be measured and paid for per each.
- (f) **Remove LED Blank-out Sign** shall be measured and paid for per each.
- (g) **Install Backplate on Existing Signal Head** shall be measured and paid for per each.