

809-T-244 INTELLIGENT TRANSPORTATION SYSTEM DEVICE MAINTENANCE

(Adopted 11-22-24)

Description

This work shall consist of furnishing, installing, and maintaining various intelligent transportation system, ITS, devices at various locations in accordance with 105.03 and as described herein.

Materials

Materials shall be in accordance with the following:

Auxiliary BIU Panel.....	922.02
Concrete, Class A, B, or C.....	702
Conduit.....	922.19
Controller Cabinet Foundation.....	805.13
Handhole.....	922.17
ITS Controller Cabinet.....	925
Padlock.....	925.04 (aa)
Reinforced Concrete Pipe.....	907.02
Reinforcing Bars.....	910.01

Unless otherwise specified, equipment warranties shall be provided for a period that is customary and normal for the manufacturer but shall not be less than two years from the date of delivery or one year from the date of Component Acceptance, whichever is greater. Participation of the Department in the testing does not constitute Component Acceptance.

All procurement shall be made of new materials. The procurement shall be in accordance with the current applicable standards of the National Electrical Manufacturers Association, NEMA; Electronics Industries Association, EIA; National Electric Code, NEC; and Underwriters Laboratory, UL.

All electronic and electrical components assemblies or digital control devices that are connected to commercial power shall be UL, Underwriters Laboratories, or ETL, Electronics Testing Laboratories, listed or, shall be approved by the Engineer. Copies of UL or ETL product cards shall be provided to the Engineer. All data and low power connections shall be accomplished via positive locking mechanisms.

All electronic devices shall be solid state and reflect the latest advances in state-of-the-art design.

Construction Requirements

Installation of the Auxiliary BIU Panel shall be in accordance with 805.08.

Connectors, terminals, bus joints, and mountings shall be checked for tightness by the Contractor. Field-connected connectors and terminals, including screws and bolts, shall be tightened in accordance with the equipment manufacturer's published torque tightening values. Where the manufacturer's torque requirements are not specified, the Contractor shall tighten connectors and terminals to comply with tightening torques specified in UL486A. Scratches and mars of finish shall be touched up to match original finish. The Contractor shall remove paint splatters and other spots, dirt, and debris.

Working Drawings

Working drawings shall be submitted in accordance with 105.02 for wiring diagrams, system schematics, submittal data, as-built documentation, and manuals and maintenance documentation.

Working drawings of wiring diagrams and system schematics shall include the following:

- (a) Wire designations by color or labels for every piece of field equipment in every cable segment between the equipment.
- (b) Appropriate designations for every cable and conduit segment. All conduits carrying electrical cables shall be marked or labeled at all maintenance points and points of access. Designations shall include terminology such as, "Power Distribution - 480 VAC", "Video Coax", and the like. All designations shall be submitted to the Engineer for approval prior to submittal.
- (c) Show locations of all cable splices.
- (d) Show connections to all communications equipment at the remote sites, CDP sites, Traffic Signals, and at the Traffic Management Center.
- (e) All radio equipment documentation packages shall include system diagrams, interconnection drawings, parameter lists and optimization procedures.
- (f) Prints of the schematic diagrams applicable to the equipment contained in cabinets or the communication shelters shall be provided by the Contractor.

Working drawings of submittal data shall meet the following requirements:

- (a) Prior to the purchase or fabrication of any equipment or material, the Contractor shall submit for approval by the Engineer catalog cut sheets and specifications for all standard, off-the-shelf items. The Engineer may require verification of performance, which shall be provided with the catalog cut sheets and specifications.
- (b) The Contractor shall label each item of submittal data with the bid item number or other description of the items to which it applies. Each submittal of catalog cut sheets or specifications, shall contain sufficient information and details to allow the Engineer to evaluate the particular component.
- (c) Copies of the catalog cut sheets, specifications, shall be submitted to the Engineer and the ITS Field Engineer designated at the preconstruction meeting. All catalog cut sheets and specification submittal data shall be submitted within 30 calendar days following issuance of the Notice to Proceed. All other working drawings of submittal data shall be submitted within 90 calendar

days following issuance of the Notice to Proceed. Failure to submit catalog cut sheets, specifications, and working drawings within this time frame shall result in liquidated damages of \$1,000 per day to be withheld from the Contractor payment, not as a penalty but as damages sustained for each day the documentation is late.

- (d) All submittals returned to the Contractor as rejected shall be resubmitted for approval within 14 calendar days from the notice of rejection. Failure to resubmit documentation within the 14 calendar days from notice of rejection will result in liquidated damages of \$1,000 per day to be withheld from Contractor payment, not as a penalty but as damages sustained for each day the documentation is late.
- (e) The submittal data shall include a minimum of the following items. Any item included in this list that is not a deliverable of the contract may be removed from the requirements with approval by the Engineer.
 - 1. Fiber optic cable
 - 2. Fiber optic drop cable assemblies
 - 3. Fiber optic patch panels
 - 4. Fiber optic patch cables
 - 5. Fiber optic break out kit and connectors
 - 6. Fusion splice protection kit
 - 7. Fusion splice enclosure
 - 8. Vaults
 - 9. Handholes
 - 10. Handhole and vault rings & lids
 - 11. Cable duct markers, concrete
 - 12. Cable duct markers, flexible, including decal design
 - 13. All conduits
 - 14. All electrical cables
 - 15. Conduit splicing methods and materials
 - 16. ITS Cabinet
 - 17. Microwave Detector
 - 18. Mast Arm for mounting microwave detector
 - 19. Light Pole for mounting microwave detector
 - 20. Camera Lowering Device
 - 21. Camera Assembly
 - 22. CCTV CAT6 Outdoor Cable.
- (f) The Contractor may submit alternatives to the Department for consideration. Any alternative submitted shall be identified with benefits stated and documented.

Working drawings of as-built information, shall be provided by the Contractor prior to final acceptance. The Contractor will be provided with existing as-builts for the proposed locations for conduit, cabinets, and devices. On a level containing no proposed information, the Contractor shall draw in the final as-built locations for the cabinet foundation, detectors, handholes, detector housings, conduits including burial depth, and device locations for any field devices worked on at the site that changed location. These drawings shall be returned in both electronic and paper format.

Working drawings of as-built information shall include the GPS coordinates accurate within 3 ft of CCTV, DMS, handhole, travel time sign, cabinet, service point, or vault locations. The coordinates shall be noted on as-builts in a single spreadsheet in decimal degree format and note the type of device, direction, and reference post or mile marker. For example, an entry of Vault, 41.657988, -86.890585, I-94, EB, 34.3 would be for a vault placed on eastbound I-94 at mile marker 34.3 near the interchange with US 421.

General Requirements

(a) Component Maintenance

After Component Acceptance, the Department Traffic Signal or ITS Technology Support Division will assume all troubleshooting maintenance responsibilities and functional responsibility at the component level. The Department will notify the Contractor if a component level failure occurs within the contract or warranty period, at which time the Contractor shall provide or replace the component within. It will be at the Department's discretion to determine whether the Contractor shall provide the components to the Department or install them. It shall be the Contractor's responsibility to provide for advanced replacement components or purchase spare parts to ensure that the timeframe for component replacement is met.

Component Maintenance shall be considered incidental to the cost of equipment being provided on this contract and will not be paid for separately.

(b) Electrical Power

The electrical power requirements shall be in accordance with the following:

1. Operating Power: The equipment shall operate on 120 volts, 60 Hz, single-phase unless otherwise specified. It shall conform to its specified performance requirements when the input voltage varies from 89 to 135 volts and the frequency varies ± 3 Hz.
2. High Frequency Interference: The equipment operation shall be unaffected by power supply voltage spikes of up to 150 volts in amplitude and 10 microseconds duration.
3. Line Voltage Transients: The equipment operations shall be unaffected by voltage transients of plus or minus 20% of nominal line voltage for a maximum duration of 50 milliseconds. Equipment in the field shall meet the power service transient requirement of NEMA Standard TS-1 when connected to the surge protectors in the cabinet.
4. Protection: All equipment shall use readily accessible, manually resettable or replaceable circuit protection devices, such as circuit breakers or fuses, for equipment and power source protection.
5. Brownouts: The equipment shall not be damaged when the main power drops to 95 VAC for a period of eight hours. If the equipment does not operate normally at 95 volts, the equipment shall automatically resume normal operation

within five seconds after normal power returns.

6. ITS service point shall be Single phase 240/120 AC, 100 A. It shall consist of multi circuit breaker power panel with 100A main and at least four two-pole branch breakers in 3R rated enclosure. If service point and more than 700 ft, or across the road, or ramp from the devices, disconnect only shall be installed in the immediate vicinity of the device. Meter base and circuit breaker panel shall be installed as an underground service point.

(c) Temperature and Humidity:

The temperature and humidity requirements shall be in accordance with the following:

1. Field Equipment: Equipment in the field shall meet the temperature and humidity requirement of NEMA Standard TS-1. Liquid crystal displays shall be undamaged by temperatures as high as 165°F, and shall produce a usable display at temperatures up to 122°F.
2. Central Equipment: Central equipment shall operate normally at any combination of temperatures between 50°F and 104°F, and humidity between 5% and 90%, non-condensing, and with a temperature gradient of 41°F, per hour.

(d) Wiring

The wiring requirement shall be in accordance with the following:

Every conductor, except a conductor contained within a single piece of equipment, shall terminate either in a connector or on a terminal block. The Contractor shall provide and install the connectors and terminal blocks where needed. Approved splice kits shall be used instead of connectors.

Connectors shall be labeled and keyed to preclude improper connection. The permanent labeling methods shall be as approved by the Engineer prior to use.

Appropriate designations shall be used for every conduit and cable segment. All conduits carrying electrical cables shall be marked or labeled at all maintenance points and points of access. Designations shall include terminology such as, "Microwave Composite Cable", "Video Fiber", "Video Ethernet Cable". All designations shall be as approved by the Engineer. Labels shall be in accordance with these Special Provisions.

Personnel shall be protected from accidental contact with all dangerous voltages.

Conductors carrying AC power shall not be installed in the same wiring harness as conductors carrying DC control or communication or video signals.

Wiring shall be arranged so that any removable assembly can be removed without disturbing wiring that is not associated with the assembly being removed.

All splices, excluding permissible fiber optic cable, shall be in

equipment cabinets. Fiber optic splices shall be in ATMS vaults. All splices shall be watertight and capable of satisfactory operation under continuous submersion in water. Splicing materials, insulation, and techniques shall be as approved by the Engineer.

Electrical cables shall have at least 10 ft of slack in all handholes and 6 ft of slack in all cabinets, unless otherwise approved by the Engineer.

Unless otherwise stated herein, hot dipped galvanized steel shall be used for all exposed metal surfaces. Corrosion protection shall be provided between dissimilar metals.

(e) Serviceable Parts

The Contractor shall certify that all serviceable parts are commercially available or readily available from the system vendors and suppliers. The system vendors and suppliers shall provide a letter to the Department stating that all current and future models of serviceable parts for all ATMS equipment components shall be backwards compatible. Components that shall be backwards compatible include, but are not limited to vehicle detectors, closed circuit television cameras, pan-tilt-zoom mechanisms, all video control equipment, component software, and all communication equipment including fiber optic equipment, radios, antennas, and cables.

Parts shall be shipped within five business days of receiving an order from the Department. These parts, at a minimum, shall be easily serviceable by the Department maintenance personnel using standard tools or tools provided to the Department by the Contractor. The Department will not agree to any implied or written arrangement to purchase any part from an exclusive source.

Any maintenance activity performed on the unit due to a failure shall be documented, and shall include an explanation of all failures, the date that the equipment was removed from the cabinet, the repairs that were made, the date and nature of any tests made to check the correct operation of the unit, and the date and the location where the unit was reinstalled in the field.

(f) Warranties

1. General Equipment Warranty. Any equipment warranty shall be considered incidental to the cost of the equipment being provided on this contract and will not be paid for separately.
2. Camera Lowering System Warranty. The Contractor shall provide a manufacturer's warranty against defects of furnished material and workmanship for a period of five years after final acceptance for each complete installation. The Contractor shall include labor for removal and reinstallation of a failed unit. Warranty shall include complete connector assembly replacement for contacts failing due to water ingress and corrosion damage.
3. Serviceable Part Warranty. The warranty shall cover, at a minimum, all work and materials for all equipment components and hardware installed or repaired including,

but not limited to, all communication equipment such as fiber terminations, radios, antennas and all connecting cables, all devices such as microwave detectors, saw cut loop detectors, camera lowering arm assemblies, and accessible pedestrian systems. Documentation shall be provided for all equipment to show compliance with the warranty requirements.

After each repair conducted, prior to the acceptance, the warranty period shall be renewed. No more than one repair will be allowed prior to acceptance. If a second repair is required, the equipment shall be replaced in kind with a new warranty period.

(g) Electrical Identification

The Contractor shall label all new electrical equipment and conduits installed for ATMS equipment and label electrical materials, equipment, and installations, including buried electrical line warnings, conduits, cables, and conductors in accordance with NFPA 70 of the NEC and cable and raceway labels shall also be in accordance with ANSI Standard A13.1, Scheme for the Identification of Piping Systems.

Labels that are not provided by the device manufacturer shall be selected from one of the following suppliers:

1. American Labelmark Co.
2. Ideal Industries, Inc.
3. National Band and Tag Co.
4. Panduit Corp.
5. Seton Name Plate Co.
6. Standard Signs, Inc.
7. W.H.Brady, Co.

Labels shall meet the following additional requirements:

1. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service, Power, ATMS.
2. Label Size for conduits larger than 1 in.: 1.10 in. high by 7.87 in. long. Color: Black legend on orange background.
3. Colored Adhesive Marking Tape for Conduits, Wires, and Cables: Self- adhesive vinyl tape not less than 0.003 in. thick by 0.98 in. to 1.96 in. width.
4. Underground Line Marking Tape: Permanent, bright-colored, continuous- printed, plastic tape compounded for direct-burial service not less than 5.88 in. wide by 0.004 in. thick. Printed legend indicative of general type of underground line below.
5. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self- adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
6. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic

laminate, 0.059 in. minimum thick for signs up to 20.0 sq in., or 7.87 in. in length; 0.118 in. thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

7. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.177 in. minimum width, 48.5 lb minimum tensile strength, and suitable for a temperature range from -50°F to +348.8°F. The Contractor shall provide ties in specified colors when used for color coding.
8. Color Coding: The Contractor shall provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

CONDUCTOR COLOR CODING CONVENTION		
Phase	120/240 Volts	240/480 Volts
A	Black	Brown
B	Red	Orange
Neutral	White	White
Ground	Green	Green

Table 1

For phase conductors at a weatherhead: Identify conductors with pressure sensitive plastic tape applied in half-lapped turns for a distance of 6 in. from the terminal points and in boxes where splices are made.

For phase conductors at all other locations: Identify conductors with factory applied color the entire length of the conductors or pressure sensitive plastic tape applied in half-lapped turns for a distance of 6 in. from the terminal points and in boxes where splices are made.

For Neutral and Ground conductors: The Contractor shall use conductors with color factory- applied the entire length of the conductors except as follows:

The following field-applied color-coding methods may be used for receptacle phase conductors on sizes larger than No. 6 AWG.

Pressure-sensitive plastic tape shall be applied in half-lapped turns for a distance of 6 in. from terminal points and in boxes where splices or taps are made. The last two laps of tape shall be applied with no tension to prevent possible unwinding. The Contractor shall use 1 in. wide tape in colors as specified. The Contractor shall not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

In lieu of pressure-sensitive tape, cable ties may be used for color identification. Three ties of specified color shall be applied to each wire at each terminal or splice point starting 3 in. from the terminal and spaced 3 in. apart. A special tool or pliers shall be used to, tighten for a snug fit, and cut off excess length.

9. The Contractor shall tag or label conductors as follows:

Where multiple branch circuits are present in the same conduit, box or enclosure, label each conductor or cable, including each neutral.

The Contractor shall provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring in each panel.

Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation.

The Contractor shall use consistent letter/number conductor designations throughout on wire/cable marking tapes. Warning, caution, and instruction signs and stencils shall be applied as follows:

The Contractor shall install warning, caution, or instruction signs where required by NEC or OSHA, where indicated, or where required to assure safe operation and maintenance of electrical systems and of the items to which they connect.

The Contractor shall install engraved plastic-laminated instruction signs with an approved legend where instructions or explanations are needed for system or equipment operation.

The Contractor shall install butyrate signs with metal backing for outdoor items.

The Contractor shall coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. The Contractor shall install numbers, lettering, and colors as approved in submittals and as required by code. The Contractor shall install identification devices in accordance with the manufacturer's written instructions and requirements of NEC.

During trench backfilling, for exterior underground power, signal, and communications lines, the Contractor shall install continuous underground plastic line markers, located above line at 6 in. to 8 in. below finished grade.

Where multiple lines are installed in a common trench or concrete envelope and do not exceed an overall width of 16 in., the Contractor shall install a single line marker.

(h) Documentation and Submittals

Two manuals shall be supplied for any microwave detectors, loop detector amplifiers, Sensys equipment, accessible pedestrian systems, and any camera lowering systems provided on this contract. A reproducible form of the manual shall also be provided. The manuals supplied for the off-the-shelf items shall be those supplied by the equipment manufacturer.

Manuals shall include, at a minimum, the following material, when applicable:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures shall include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting, disassembly, repair, and reassembly, aligning and adjusting instructions.
4. Servicing instructions and schedules.

The Contractor shall provide a maintenance history for each piece of electronic equipment provided on this contract. The history shall include the equipment type, model and serial numbers, date of manufacture, date and location of installation, date of all associated tests required by these specifications and the performance of the equipment during these tests.

Any maintenance activity performed on the unit because of a failure shall be documented, and shall include an explanation of all failures, date that the equipment was removed from a cabinet, the repairs that were made, the date and nature of any tests made to check the correct operation of the unit, and the date and the location where the unit was reinstalled in the field.

After each repair conducted, prior to the acceptance, the warranty period shall be renewed. No more than one repair will be allowed prior to acceptance. If a second repair is required, the equipment shall be replaced in kind with a new warranty period.

(i) Maintenance of Traffic

Maintenance of traffic shall be in accordance with 801 and the Work Zone Safety Guidelines for Construction, Traffic Maintenance, and Utility Operations manual. All costs associated with maintenance of traffic activities including labor, materials, permits, and equipment shall be included in the cost of maintaining traffic. No additional payment will be made for Maintenance of Traffic activities. If conditions other than those shown in the Work Zone Safety Guidelines manual or the plans occur, the Contractor shall provide the Engineer with a proposal for the traffic control measures to be used, subject to approval.

The Contractor will not be allowed to perform any repair activities on the following Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day. Additionally, the Engineer may prohibit work at certain locations on specific days based on special events taking place nearby.

It is anticipated that the majority of the work to be performed under this contract will either be on the shoulder or off the roadway. The sites to be worked on will be at the discretion of the Engineer. In instances where a lane or shoulder will be affected, mostly for microwave radar in center medians and RWIS in--pavement detection replacement, an interstate lane closures shall be submitted for the Engineer's approval

at least 1 week in advance to comply with Department Interstate Highways Congestion Policy.

The Contractor shall use the most current approved Interstate Highways Congestion Policy for this work and the most current approved exception for 'Maintenance Waiver for Miscellaneous Work'. It shall be confirmed by the Engineer to be the latest approved exception with the respective District Traffic Engineer.

Construction warning lights shall be in accordance with the applicable requirements of 801.14, except the plastic drums or construction warning signs used only for maintaining traffic during daylight hours will not require Type A low intensity flashing warning lights.

When aerial work is being performed, traffic shall not be allowed to pass beneath personnel working overhead.

If the Contractor finds it necessary to temporarily occupy a part of a shoulder or the traveled width of pavement and restrict traffic, the Contractor shall provide, all cones, barrels, arrow boards, barricades, lights, flaggers, signs, attenuators, and other traffic control devices in accordance with the Department's standard drawings and the IMUTCD, and as deemed necessary by the Engineer, at no additional cost to the Department.

(j) Railroad Restrictions

No work shall take place within 50 ft of any railroad, including staging materials or equipment.

(k) Required Meetings

The Contractor shall attend the pre-construction conference, in accordance with 108.04, and at least one telephone conference call meeting per calendar month. The Contractor and pertinent state personnel shall attend a semi-annual conference in person at a location as determined by the Engineer.

Forms for work processes will be provided at the pre-construction conference.

(l) System Continuity and Allowable Downtime

With the exception of the devices identified in this specification, all system components of the ATMS from prior phases shall remain operational during construction. Any interruption of the systems required for integration, power system upgrades or testing new components shall be coordinated and as approved by the Department's ITS Technology Deployment Technician Supervisor a minimum of 72 h prior to the scheduled interruption. Each component of the Indianapolis ATMS non-operational without proper notice will result in liquidated damages of \$1,000 per day to be withheld from the Contractor payment, not as a penalty but as damages sustained for each day without the proper notice. If the interruption exceeds 24 h, each additional day that any component remains non-operational will result in liquidated damages of \$5,000 per day to be withheld from Contractor payment, not as a penalty but as damages sustained for each day any component remains non-operational.

Equipment downtimes at all other sites shall be limited to the time required to disconnect and reconnect cable from switches and patch panels, as required. Prior to cutting and splicing the existing fiber optic cable,

the Contractor shall verify that no devices are currently communicating over the fiber optic cable in question. This verification effort may require the Contractor to physically unplug and re-plug fiber optic patch cables at each of the cabinets and shelters along the backbone fiber optic link.

System continuity and allowable downtime shall be considered incidental to the cost of equipment being provided on this contract and will not be paid for separately.

(m) Work Order Contract Supplemental Conditions

1. Initiation of a Work Order: As needs arise, the Engineer will notify the Contractor of a Project, schedule a Joint Scope Meeting, and issue a Notice of Joint Scope Meeting.

The Contractor shall attend the Joint Scope Meeting and discuss, at a minimum, the general scope of the work, alternatives for performing the work and value engineering, access to the site and protocol for admission, hours of operation, staging area, requirements for technical data, samples and working drawings, requirements for professional services, sketches, drawings, and specifications, construction start date, construction duration, liquidated damages, and the presence of hazardous materials. A written scope of work may be issued to the Contractor in lieu of holding a Joint Scope Meeting at the discretion of the Engineer.

The Contractor shall compile the information listed above into a Work Order Request Form which shall be given to the Engineer no later than 14 business days following the Joint Scope Meeting or following issuance of a written scope of work. In the event of an emergency concerning public safety, the duration may be shortened to 24 hours upon the Engineer's request. Failure to submit the Work Order Request Form in the allotted time will result in liquidated damages of \$500 per day to be withheld from Contractor payment, not as a penalty but as damages sustained for each day work is delayed.

Upon completion of the Work Order Request Form, the Engineer will review the Work Order Request Form for completeness and the intent of the scope of work. The Engineer shall complete their review within two business days and unless modified by either the Contractor or the Engineer, the Work Order Request Form will be the basis for the work order, including the work order price proposal, completion timeline and the start of work date. If the Work Order Request Form is modified, one business day shall be given for review.

The Contractor shall make the necessary arrangements for and obtain all filings and permits required for the Work, including, but not limited to, the preparation of all drawings, sketches, calculations and other documents and information that may be required.

The Contractor shall provide construction engineering

services required in connection with a particular Work Order including drawings and information required for filing.

For Work Orders requiring incidental engineering drawings and approvals and permits, allowance will be made to provide adequate time for preparation and submittal of the necessary documents. Additional time may be granted at the discretion of the Engineer.

2. Review of the Work Order Request Form and Issuance of the Work Order: The Engineer will evaluate the entire Work Order Request Form and compare that with the Engineer's estimate of the scope of work to determine the reasonableness of approach, including the appropriateness of the tasks and quantities proposed. The Work Order will be a fixed price based on the schedule of prices for the pay items. The Department is under no obligation to issue any Work Orders against this Contract in excess of the minimum guarantee.

The Contractor may choose the means and methods of construction, subject to the Department's right to reject any means and methods proposed by the Contractor that:

Will constitute or create a hazard to the Work, or to persons or property,

Will not produce finished Work in accordance with the terms of the Contract; or

Unnecessarily increases the price of the Work Order when alternative means and methods are available.

The Engineer reserves the right to reject a Work Order Request Form or cancel a Project for any reason. The Department also reserves the right not to issue a Work Order if it is determined to be in the best interests of the Department. The Department may perform such work by other means. The Contractor shall not recover any costs arising out of or related to the development of the Work Order including, but not limited to, the costs to attend the Joint Scope Meeting, preparing a Work Order Request Form, including incidental and engineering services, subcontractor costs, and the costs to review the Work Order Request Form with the Engineer.

By submitting a Work Order Request Form to the Engineer, the Contractor agrees to accomplish the scope of work in accordance with the scope discussed at the Joint Scope Meeting or outlined in the written scope of work.

Each Work Order provided to the Contractor shall reference the detailed scope of Work and set forth the Work Order Price and the Work Order Completion Time. All clauses of this Contract shall be applicable to each Work Order. The Work Order, signed by the Department and delivered to the Contractor, constitutes the Department's acceptance of the Contractor's Work Order Request Form. A signed copy of the Work Order Request Form will be provided to the

Contractor along with a Notice to Proceed for the Work Order. The Notice to Proceed will include the Work Order Completion Time in accordance with 101.55. In the event of emergency repair, this Work shall consist of the Contractor performing emergency, unscheduled, repairs and emergency response throughout the District at various locations in accordance with 105.03.

The Contractor shall have 15 business days from the issuance of a Work Order to complete the scope of work agreed upon. The Contractor may request additional time in their Work Order Request Form and shall provide documentation supporting the request. The Engineer may approve additional time for external delays with proper documentation.

The Contractor shall, when directed by the Engineer, make an emergency response to clear signal equipment components which are on the roadway and are causing a hazard to the public at any of the locations shown on the plans.

Camera Lowering System

Camera lowering systems shall be selected from the Department's Qualified Product List. The camera lowering system shall include two CAT6 Power-over-Ethernet cables to connect the camera to the cabinet.

CCTV Camera

CCTV Cameras shall be installed in accordance with the manufacturer's instructions. All materials shall be installed in a neat and professional manner. All installation services shall comply with all warranty provisions and warranty contract maintenance services in accordance with these specifications. All installation services shall comply with all local and state electrical codes, and Motorola R-56 requirements. All wiring entry to the CCTV Camera shall use watertight fittings. All wiring entry and exits shall be made at the side or underneath components; no exposed top entry or exits will be allowed. This requirement extends to all enclosures, junction boxes, support arms, or any other externally exposed devices. CCTV Cameras shall be selected from the QPL of Traffic Signal and ITS Devices for the designated application.

Conduit

HDPE conduits shall be in accordance with 922.19. Schedule 80, coil able, HDPE conduit shall be color coded orange, green, and blue for communications cable and black for power cable. The HDPE shall meet or exceed the properties listed in ASTM D3350 for minimum cell classification of Class E Colored with UV Stabilizer. The properties and dimensions shall be in accordance with ASTM F2160 standard specification for Solid Wall High Density Polyethylene Conduit Based on Controlled Outside Diameter, OD.

Fiberglass conduit shall be manufactured to NEMA TC-14 2002 standards and listed by Underwriters Laboratories, UL, standard 1684 "Above Ground and Below Ground". Carbon black shall be used as an ultraviolet inhibitor. All fiberglass conduit shall be Iron Pipe Size, IPS, "Standard Wall" with a minimum 0.07 in. wall thickness, and a minimum impact resistance in accordance with the following table and in accordance with ASTM D2444.

FIBERGLASS CONDUIT IMPACT RESISTANCE	
Conduit Size	Standard Wall Impact Resistance
2 in.	40 lbs ft
3 in.	60 lbs ft
4 in.	70 lbs ft
5 in.	100 lbs ft
6 in.	100 lbs ft

PVC and steel conduits shall meet the requirements of section 922.19.

Liquid-tight Flexible Metal Conduit, LFMC, shall consist of a single strip of continuous, flexible, interlocked galvanized steel inside and out, forming a smooth internal wiring channel with a liquid tight covering of UV resistant flexible PVC. LFMC shall be manufactured in accordance with UL-360. All liquid-tight connectors shall be UL/CSA listed for wet locations.

(a) General

Conduit placement shall be in accordance with 807.06, except as noted herein. The Contractor shall install conduits underground by means of trenching or directional drilling. The Contractor shall determine final routing based on actual field conditions at each site, including utility locator service markings, to assure no conflicts with existing utilities. All conduits shall be placed a minimum of 3 ft below existing grade, except for immediately adjacent to handholes or vaults. All conduits shall be stubbed out a minimum of 6 in. into each handhole or vault.

Conduit pushes shall be in accordance with 805.11 and 807.06. The Contractor shall verify the existing pavement conditions prior to construction to avoid cracking the pavement.

All flexible roadside delineators disturbed during trenching operations shall be restored or replaced at no additional cost to the contract.

The Contractor shall determine all utility locations near the path of the proposed conduit, including depth. The Contractor shall use this information to avoid damage to utilities or facilities within the work area. The Contractor shall provide this information, including the source, to the Engineer a minimum of five working days prior to install of the conduit. The Contractor shall not install any conduit until the Engineer approves the submittal.

Prior to installation, the Contractor shall expose all utilities for which it is customary and safe to do so.

The diameter of the drilled hole shall conform to the outside diameter of the conduit of conduits as closely as practical. The Contractor shall pressure grout, as directed by the Engineer, to fill any voids, which develop during the installation operation. The Contractor shall remove and replace any conduit damaged in directional drilling operations at no expense to the project.

The use of water and other fluids in connection with the drilling operation will be allowed only to the extent necessary to lubricate

cuttings. Jetting will not be allowed, and the use of water alone as a drilling fluid will not be allowed. The Contractor shall use a drilling fluid/slurry consisting of at least 10% high grade, processed Bentonite to consolidate excavated material, seal the walls of the hole, and furnish lubrication for subsequent removal of material and immediate installation of the conduit.

The Contractor shall provide a means of collecting and containing drilling fluid/slurry that returns to the surface, such as slurry pit, or a method approved by the Engineer. The Contractor shall provide measures to prevent drilling fluids from entering storm sewer systems. The Contractor shall prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other pedestrian walkways, driveways, or streets. The Contractor shall immediately remove any transport waste drilling slurry from the site and dispose of it. The Contractor shall not allow slurry to enter wetlands. The Contractor shall protect wetlands using appropriate stormwater control measures approved by the Engineer.

The Contractor shall use a digital walkover locating system to track the drill head during the bore. At minimum, the locating system shall be capable of determining the pitch, roll, heading, depth, and horizontal position of the drill head at any point along the bore. During each drilling operation, the Contractor shall locate the drill head every 10 ft along the bore and prior to crossing any underground utility or structure. Upon completion of the drilling operation and conduit installation, the Contractor shall furnish the Engineer with an as-built profile drawing and plan drawing for the drilled conduit showing the horizontal and vertical locations of the installed conduit.

(b) Conduit on Structure

Fiberglass conduit shall be provided for all above ground locations where the conduit shall be attached to a bridge in accordance with 807.06 and as specified herein. Fiberglass conduit runs shall be continuous between handholes with the exception that expansion joints shall be provided for every 200 ft of conduit, or as recommended by the conduit manufacturer. Fiberglass fittings and expansion joints shall be of the same material and from the same manufacturer as the fiberglass conduit. If rebar is struck while drilling lag screw holes into the bridge, drilling shall cease immediately and the hole shall be patched using an epoxy compound approved by the Engineer for patching concrete.

(c) HDPE Conduit Splicing

All HDPE conduit splices shall be fusion splices, unless mechanical splices are approved in writing by the Department's ITS Technology Support Division Director. At a minimum, mechanical couplers shall be airtight, transparent, and capable of withstanding the maximum allowable air pressure for the fiber cable blowing equipment.

(d) Reattaching Existing Cabling

Some locations within this contract may require the Contractor to disconnect and pull existing cables free from and old conduit and then reconnect the cables to existing or new equipment. The cost of disconnecting, pulling back, re-pulling, and reconnecting existing cables shall be included in the bid price of the new conduit.

Cable and Wire

(a) General

Subject to compliance with requirements, manufacturers offering

products that may be incorporated in the work include, the following:

Wires and Cables:

1. American Insulated Wire Corp., Leviton Manufacturing Co.
2. Brand-Rex Cable Systems, Brintec Corp.
3. Carol Cable Company, Inc.
4. Senator Wire & Cable Co.
5. Southwire Co.

Connectors for Wires and Cables:

1. Teledyne Penn-Union
2. ILSCO
3. Thomas & Betts Corp.
4. Electrical Products Division, 3M Co.
5. O-Z/Gedney Unit, General Signal

Oxidation Inhibitor Compound for Terminations:

1. Noalox, Ideal Industries
2. De-OX, Ilsco
3. Penetrox, Burndy

All conductors shall have insulation rated at 600 VAC, with conductor temperatures not to exceed 194°F in dry locations and 167°F in wet locations.

Branch Circuits: Type XHHW, copper conductor, in conduit at ATMS equipment cabinets/enclosures.

Connectors and Splices: UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Connectors and Splices shall comply with the project's installation requirements.

(b) Installation

Wire and cable installation shall be in accordance with the applicable portions of 807, 805, and 920.01(c). Wire and cable shall be delivered in accordance with NEMA WC-26.

The Contractor shall coordinate layout and installation of cable with other installations. The Contractor shall revise locations and elevations from those indicated as required to suit field conditions, as approved by the Engineer.

All components and installation shall comply with NFPA 70, National Electrical Code. The Contractor shall provide products specified in this Section that are listed and labeled as defined in the National Electrical Code, Article 100.

The Contractor shall install wires and cables as specified, in accordance with the manufacturer's written instructions and the NECA, Standard of Installation.

The Contractor shall pull conductors into raceway simultaneously where more than one is being installed in same raceway. The Contractor shall use pulling compound or lubricant where necessary. The compound used shall not deteriorate conductor or insulation. The Contractor shall

use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that shall not damage cables or the raceway.

The Contractor shall minimize conductor splices where possible. All splices and connections shall be in accordance with 807, except that no splices shall be made in underground locations, vaults, or handholes. The Contractor shall install splices and covers that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

The Contractor shall use splice and tap connectors that are compatible with conductor material.

The Contractor shall examine conduits to receive wires and cables for compliance with installation tolerances and other conditions. The Contractor shall not proceed with installation until unsatisfactory conditions have been corrected.

Testing: Upon installation of wires and cables and before electrical circuitry has been energized, the Contractor shall demonstrate product capability and compliance with requirements.

Procedures: The Contractor shall perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.

The Contractor shall correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, the Contractor shall remove and replace with new units, and retest.

Anti-Oxidation Treatment: The Contractor shall apply anti-oxidation compound to all electrical terminations.

(c) Fiber Optic Cable Splice

Splice Enclosures: Splice Enclosures shall be designed for use under the most severe conditions such as moisture, vibration, impact, cable stress, and flex temperature extremes as demonstrated by successfully passing the factory test procedures and the minimum specifications listed below:

Physical Requirements: The enclosures shall provide ingress for up to four cables in a butt configuration. The closure shall prevent the intrusion of water without the use of encapsulates.

The enclosure shall be capable of accommodating splice organizer trays that accept mechanical or fusion splices. The splice enclosure shall have provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or un-spliced fiber. Splice organizers shall be re-enterable. The splice case shall be UL rated.

Enclosure re-entry and subsequent reassembly shall not require specialized tools or equipment, and these operations shall not require the use of additional parts.

The splice enclosure shall have provisions for controlling the bend radius of individual fibers to a minimum of 1.5 in.

For splices in armored cables, the splice closure shall provide a method of bonding the armor from all sheaths entering the closure. It shall also provide a means of grounding the armor and closure at the splice location.

1. Splice Testing

Factory Testing:

Factory testing shall be in accordance with the following:

Compression Test:

The closure shall not deform more than 10% in its largest cross-sectional dimension when subjected to a uniformly distributed load of 1335 N at a temperature of 0°F and 100°F. The test shall be performed after stabilizing at the required temperature for a minimum of two hours. It shall consist of placing an assembled closure between two flat parallel surfaces, with the longest closure dimension parallel to the surfaces. The weight shall be placed on the upper surface for a minimum of 15 minutes. The measurement shall then be taken with weight in place.

Impact Test:

The assembled closure shall be capable of withstanding an impact of 28 N-M at temperature of 0°F and 100°F. The test shall be performed after stabilizing the closure at the required temperature for a minimum of two hours. The test fixture shall consist of 20 lb cylindrical steel impacting head with a 2 in. spherical radius at the point where it contacts the closure. It shall not exhibit any cracks or fractures to the housing that would preclude it from passing the water immersion test. There shall be no permanent deformation to the original diameter or characteristic vertical dimension by more than 5%.

Cable Gripping and Sealing Testing:

The cable gripping and sealing hardware shall not cause an increase in fiber attenuation in excess of 0.05 dB/fiber at 1550 nm when attached to the cables and the closure assembly. The test shall consist of measurements from six fibers, one from each buffer tube or channel, or randomly selected in the case of a single fiber bundle. The measurements shall be taken from the test fibers before and after assembly to determine the effects of the cable gripping and sealing hardware on the optical transmission of the fibers.

Vibration Test:

The splice organizers shall securely hold the fiber splices and store the excess fiber. The fiber splice organizers and splice retaining hardware shall be tested in accordance with EIA Standard FOTP-II, Test Condition I. The individual fibers shall not show an increase in attenuation in excess of 0.1 dB/fiber.

Water Immersion Test:

The closure shall be capable of preventing a 10 ft water head from intruding into the splice compartment for a period of seven days. Testing of the splice closure will be accomplished by placing the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Continuous pressure shall be applied to the vessel to maintain a hydrostatic head equivalent to 10 ft on the closure and cable. This process shall be continued for 30 days. The Contractor shall remove the closure and open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure.

Certification:

It is the responsibility of the Contractor to ensure that either the manufacturer, or an independent testing laboratory has performed all the above tests, and the appropriate documentation has been submitted to the Department. Manufacturer certification is required for the model of closure supplied. It is not necessary to subject each supplied closure to the actual tests described herein.

2. Splice Installation

The Contractor shall splice optical fibers from different cable sheaths and protect them with a splice enclosure and splice trays at the locations listed in the signal list. Fiber splicing consists of in-line fusion splices for all fibers described in the cable plan at the particular location.

Underground splice enclosures shall be installed in ATMS Vaults at the vault locations. The Contractor shall seal the splice closure and pressure test it following the manufacturer's instructions. Dry water-blocking compound shall be placed in the closure during this process.

The Contractor shall secure the Splice Closure to the side of the splice facility using cable support brackets. All cables shall be properly dressed and secured to rails or racks within the vault. No cables or enclosures will be allowed to lie on the floor of the splice facility. Cables that are spliced inside a building shall be secured to the equipment racks or walls as appropriate and as specified.

The enclosure shall be installed in accordance with the manufacturer's recommended guidelines.

The Contractor shall prepare the cables and fibers in accordance with the enclosure and cable manufacturer's installation practices. A copy of these practices shall be provided to the Engineer 21 days prior to splicing operations.

Using a fusion splice, the Contractor shall optimize the alignment of the fibers and fuse them together. The Contractor shall recoat the fused fibers and install mechanical protection over them.

Upon completing all splicing operations for a cable run, the Contractor shall measure the mean bi-directional loss at each splice using an Optical Time Domain Reflectometer. This loss shall not exceed 0.1 dB.

The Contractor shall measure the end-to-end attenuation of each fiber, from connector to connector, using an optical power meter and source. This loss shall be measured from both directions and shall not exceed 0.5 dB per installed kilometer of single mode cable, measured at 1310 nm.

The cable installation shall satisfy the requirements of both the National Electric Code, NFPA-70-2008, and the National Electric Safety Code, IEEE C2- 2007. The standards require that the armor be bonded and grounded any time that the armor is interrupted or exposed by opening the sheath. These documents also provide minimum separations from the foreign utilities.

For splices in armored cables, the Contractor shall ground the splice closure using a #6 AWG conductor or equivalent.

As directed by the Engineer, the Contractor shall replace any cable splice not satisfying the required objectives at no additional cost to the Department.

(d) Fiber Optic Patch Cable

The fiber optic patch cable shall be a Single Mode, 9-Micron, Duplex, Fiber Optic Cable or a Multi-Mode, 50-Micron, Duplex, Armored, Fiber Optic Cable. All conductors shall have the following specifications:

Single Mode Patch Cable:

1. Bend Radius - Meets ANSI/TIA/EIA-568B.3 standard
2. Cladding - 125 +/- 1 um
3. Core - 9.2 +/- 0.4 um
4. Crush Resistance - 750 N/cm
5. Operating Temperature - -4°F to 158°F
6. Return Loss - >/- 55 dB typical
7. Tensile Strength - 240 N (54 lb/24.5 kg)
8. Wavelength - 1310 nm, 1550 nm
9. Maximum attenuation - 0.4 dB/km at 1310 nm, 0.3 dB/km at 1550 nm.

Multi-Mode Patch Cable:

1. Bend Radius - Meets ANSI/TIA/EIA-568B.3 standard
2. Cladding - 125 +/- 1 um
3. Core - 50 +/- 2.5 um
4. Crush Resistance - 750 N/cm
5. Operating Temperature - -4°F to 158°F
6. Return Loss - >/- 20 dB typical
7. Tensile Strength - 220 N (50 lb/24.5 kg)
8. Wavelength - 850 nm, 1300 nm
9. Maximum attenuation - 3.0 dB/km at 850 nm, 1.0 dB/km at 1300 nm.
10. Protective boot and boot clip to allow up to a 90° bend on the LC end o Protective boot shall accommodate a 90° bend within 2.165 in. from the face of the connector.

The fiber optic patch cables shall be provided in accordance with the manufacturer's instructions. All materials shall be installed in a neat and professional manner. All installation services shall comply with warranty provisions and all warranty contract maintenance services shall be performed in accordance with these specifications. The Contractor shall coordinate the layout and installation of fiber patch cables with the Engineer.

All fiber optic ferrules shall be cleaned immediately prior to installation.

(e) Fiber Optic Patch Panel Assembly

The patch panel shall have brackets and all other hardware required for rack mounting in an EIA standard 19 in. equipment rack, or wall mounted as required. Alternative forms of mounting will be allowed if they are determined, by the Engineer, to be more practical at a particular location. The enclosure shall take up no more than four rack units in the cabinet or shelter unless specified as a specific rack unit size for a special application. It shall be made of powder-coated aluminum.

The enclosure shall include routing guides for jumpers, strain relief

for pigtails coming from a splice enclosure, and labels for every connector. The panel shall route fiber optic patch cables between any two connectors without reaching the patch cable's minimum bending radius.

The enclosure shall include patch panel modules with SC connectors. Each SC connector on the panel shall not cause in excess of 0.3dB optical signal loss when tested at 1310nm. The enclosure shall be designed to hold modules totaling at least 96 connectors. The enclosure shall provide enough modules for every fiber that terminates in the enclosure. The enclosure shall provide blank panels for panel positions that are not equipped with patch panels.

Patch panel enclosure and modules shall be from the same manufacturer.

The Contractor shall provide all equipment for fusion splices, pig tails, trays for organizing equipment, break out kits, connectors, labels, and other accessories required to make a complete system. Each patch panel assembly shall be fully populated with connectors and pigtails whether in use as a fiber of this project or not. All fibers shall be terminated into the patch panel assembly in either a communications shelter or cabinet location. The cost of terminations shall be included in the patch panel assembly price.

(f) Outdoor Ethernet Cable

All patch cords shall be Shielded Twisted Pair, STP, outdoor rated, and have insulation compliant with EIA/TIA 568-A Category 6a standards. The cables shall have insulation with UV rated jacketing material. Cables shall be gel filled and booted with RJ-45 connectors using the EIA/TIA-568A wiring scheme. Cables shall contain an appropriate flooding compound.

All materials shall be installed in a neat and professional manner, in accordance with 805. All installation services shall comply with all warranty provisions and warranty contract maintenance services. All installation services shall comply with all local, state, and federal building, electrical, and construction codes. The Contractor shall coordinate layout and installation of cables with other installations. The Contractor shall revise locations and elevations from those indicated, as required to suit field conditions, and shall be as approved by the Engineer.

(g) Pull Tape and Tracer Wire

Pull tape shall be made of low-stretch, woven or braided, polyester and aramid fibers with a minimum tensile strength of 400 lbs.

Tracer wires shall be a single conductor, green jacket insulated, #6 AWG copper wire. Detectable pull tape may be used as an approved substance for pull tape or tracer wire, and may be substituted for a combination of both pull tape and tracer wire.

As determined by the Department, new continuous pull tape shall be placed into each run of empty conduit from handhole to handhole or vault. A minimum of 3 ft of pull tape shall be securely tied off inside of each handhole or vault to ensure availability for future use.

As determined by the Department, a new continuous tracer wire shall be provided for all fiber optic cables. Tracer wires shall not be installed in above-ground conduits and empty conduits that are part of a duct bank that contains a non- dielectric, conductive, cable. When

multiple cables are to be installed in a conduit, all cables shall be pulled simultaneously to prevent friction damage to the cable insulation.

The tracer wire shall be securely fastened inside of the handhole or vault and connected to a fiber optic locator post when present. A waterproof wire nut or direct burial connector shall be connected to each end of the tracer wire to prevent corrosion.

Handhole Covers and Rings

(a) General Requirements

The cover frame also shall be installed in the handhole with a butyl rubber sealant in tape/coil form for a proper seal between the handhole and frame and to prevent it from moving out of place. The sealant shall be in accordance with ASTM C990 for butyl rubber sealants.

Installation shall be in accordance with 805, 807 and as shown on the plans.

The cover for the handhole shall be marked with logo imprints of "Traffic Management Systems" or "Traffic Management Power" horizontally across the cover. Covers labelled "Traffic Management Power" shall be provided whenever the handhole is used for power distribution cables. Covers labelled "Traffic Management System" shall be provided in all other instances.

(b) Specific Requirements for Vault Cover and Rings

Vault rings and covers shall be in accordance with 807.09 except the message displayed on the lid shall read "TRAFFIC MANAGEMENT SYSTEM". All vault covers shall be bolted into place to prevent accidental removal by mowing crews or other unintentional means. The cover frame shall be installed in the vault with a butyl rubber sealant in tape and coil form for a proper seal and to prevent the frame from moving out of place. The sealant shall comply with ASTM C990 for butyl rubber sealants.

Fabrication of these vault covers shall not commence until working drawings that the Contractor shall have submitted have been approved by the Engineer.

The vault cover and ring shall be installed at the planned locations as determined by the Engineer or on the site listing.

The Contractor shall clean all applicable surfaces before installing butyl sealant on the cover frame. Adhesive primer shall be used when moisture is present on surfaces. The Contractor shall follow the manufacturer's instructions for proper installation. When the installation is completed, all disturbed portions of the construction area shall be cleaned and any excess excavation or other materials shall be properly disposed of as soon as possible.

ITS Field Switches

The Contractor shall provide the following elements for each field switch conforming to the following specifications:

- (a) One - Field switch platform from the Department's QPL
- (b) One - Power supply for field switch platform from the Department's QPL

- (c) One - Rack mount kit as recommended by the field switch manufacturer
- (d) One - Field Switch Software License as recommended by the core switch manufacturer. Initial license duration shall be long enough to not require renewal before final acceptance of the contract.

The ITS Field Switches shall be delivered to the ITS Technology Deployment Division for configuration at the Indianapolis Traffic Management Center for custom configuration and programming. Upon programming, the Contractor will be notified and shall pick up the devices.

Upon configuration and programming, the Contractor shall install the ITS Field Switches in accordance with the plans and the manufacturer's instructions. Installation shall include all cables, mounting hardware, rack mount kit, power supplies with North American power cords and associated equipment required to mount and interface the communications subsystem. Installation activities shall be documented, including the output from show sys-info quantity, brand, model/part numbers, test results of all materials and devices used. The Contractor shall provide installer signed list of the materials installed with the required documentation. All cabling shall be labeled and dressed using hook and loop style straps to secure cables in cable management.

Microwave Vehicle Detector

(a) Microwave Vehicle Detector Components

The ITS microwave vehicle radar detector consists of a detector, power supply, and composite cable. The detectors shall be selected from the QPL of Traffic Signal and ITS Devices. Detector power supply shall be as recommended by the detector manufacturer. Composite cables shall be as recommended by the detector manufacturer and shall be outdoor rated and UV shielded. Mounting brackets and hardware shall be as recommended by the detector manufacturer. All mounting hardware, conduit, conduit bushings, conduit straps, cables, serial converter, power converter, surge suppressor, wires, connectors, support attachment arms, grounding wires, ground rods, grounding cables, weather heads, and all materials necessary to complete the microwave vehicle detector as specified herein shall be supplied and installed as recommended by the manufacturer.

(b) Microwave Vehicle Detector Installation

The microwave vehicle detector shall be installed in accordance with the manufacturer's instructions. All materials shall be installed in a neat and professional manner. All installation services will comply with all warranty provisions and warranty contract maintenance services in accordance with these specifications. The microwave vehicle detector manufacturer's representative shall work closely with the Engineer to prove and to test that the detector units are made operational to the satisfaction of the Engineer. The manufacturer's representative shall setup and provide data for each microwave vehicle detector unit in the presence of the Engineer.

The Contractor shall demonstrate that the microwave vehicle detector count data is within 5% of count data obtained visually over a 15 minute period for every detector installation. This test shall be performed by the Contractor in the presence of the Engineer. If detector sensitivity or calibration settings are adjusted to meet this test, the

new settings shall be recorded on the wiring diagram in the cabinet.

All microwave vehicle detector shall be installed on a tower or a new pole and pole foundation, unless otherwise specified. Mounting of the microwave vehicle detector shall be considered incidental to the cost of the microwave vehicle detector. The location of the microwave vehicle detector shall be protected to prevent the CCTV lowering device from coming down directly onto the unit.

All microwave vehicle detector units shall be installed in broadcast mode.

The Contractor shall prepare the microwave vehicle detector composite cable in accordance with the Microwave Detector User Guide to carry both power and communication from the cabinet to the detector. The composite cable shall be a home run from the detector to the cabinet, no splices will be allowed. The length of the composite cable listed in the quantity tables shall not be assumed to be the calculated length. The Contractor shall calculate the necessary length of cable based on the detector mounting height plus any necessary slack prior to ordering and preparing the detector cable.

The mounting height of the Microwave Detectors shall be in accordance with the mounting height chart provided in the Microwave Detector User Guide which is based on the setback distance from the travel lane and the total width of the lanes to be detected.

Padlocks

The padlock shall be classified as a high security padlock with a hardened shackle, laminated body, 4 pin cylinder, minimum, and come complete with a weather cover to protect the lock body and cylinder from sand, dirt, water and ice. A wafer cylinder shall not be used.

One No. 2 key shall be provided to the Department with each padlock supplied. All padlocks shall be keyed alike and be identical to the keys currently in use by the Department. The main body width of the padlock shall not exceed 3 in. and have a shackle length of 2.25 in. to 3.75 in. and a shackle diameter of 5/16 in.

For padlock information, contact:

Brian Stoner
ITS Technology Deployment Division Maintenance Supervisor
Indiana Department of Transportation
(317) 690-5534
bstoner1@indot.in.gov

Post Mounted Transformers

Transformer replacement locations require replacement of all materials except for the existing post and foundation.

The post mounted transformer shall be a dry-type 60Hz, 240/480 VAC Primary to 120/240 VAC Secondary. The kVA service shall be rated as specified in the Work Order. The enclosure shall be made of 316 Stainless Steel and meet NEMA 3R standards. A 60Hz, 50 Amp, 2 pole 480 VAC, main breaker shall be provided on the primary side of the transformer as it existed previously. The enclosure for the breaker shall be NEMA 3R, 316 Stainless Steel with a door that is capable of being padlocked. Grounding shall be in accordance with 807.12 and shall be part of the installation.

The Contractor shall install all electrical work associated with the post mounted transformer in accordance with 805, 807, and the manufacturer's written instructions and applicable requirements of NEC standards.

Power Service Drop

(a) Enclosures and Circuit Breakers

The service drops shall be sized and equipped as shown on the plans. Meter sockets shall be installed in accordance with the requirements of the utility company. Grounding shall be in accordance with 807.12 and shall be part of the service installation.

The service shall be a NEMA 3R meter base rated 120/240VAC or 480 VAC, as indicated on the work order. The panel shall be a NEMA 3R Load center equipped with a Main Circuit Breaker sized as indicated on the plans or sized for the service drop. The Contractor shall provide a minimum of 8 to 12, 1 in., single pole circuit breaker spaces. The enclosure shall be compatible with padlock protection.

Circuit breakers shall be single-pole or two-pole as required by the branch circuit. Circuit breakers shall have a minimum of 10,000 AIC for 240V circuit breakers, and 65,000 AIC for 480V circuit breakers. Panels shall be fully rated; series rated shall not be allowed.

(b) Electrical Service Requirements

Electrical service, where required, shall be provided by the power utility which services the location of the service point. The Contractor shall provide a 100 Amp, 120/240 VAC, 1-phase, 3-wire service or a 100 Amp, 480 VAC 1-phase, 2-wire service as indicated on the work order.

The service point shall be installed at locations as indicated by the work order and shall also be closely coordinated with the utility's requirements. Work under this item shall include overhead and underground service power drops.

After coordination with the electric utility's representative, the Contractor shall submit a Connection Request via email to the Department. The Connection Request email shall be sent to Jessica Kruger at: jessicakruger@indot.in.gov. The Department will forward this form to the electric utility and coordinate any account changes. The Contractor shall be responsible for paying the utility invoices for all construction related costs and the Department will be responsible for paying the monthly utility invoices after service is connected and construction is complete. The Service drops shall be in accordance with 807.15 and as specified herein.

All electrical work associated with the service power drop installation shall be in accordance with 807.15, as shown on the plans, the manufacturer's written instructions, and applicable requirements of NEC standards. As shown on the plans, at the Engineer's request, or where the proposed service point is more than 500 ft from the ATMS site, a separate lockable remote service point subpanel shall be provided at the ATMS site.

All subpanels shall have their own ground rod which is also connected to the site's grounding system. The grounding conductors and ground rod shall be bonded to all non-current carrying metal on the

subpanel.

The installation will not be considered complete until power is available at the service point site.

Remote Power Switch

The remote power switch shall be selected from the QPL of Traffic Signal and ITS Devices.

A remote power switch shall be furnished and installed at each location in accordance with the manufacturer's specifications. The switch and AC-powered devices shall be connected to the device. When IP connectivity failure is detected, it shall automatically reboot some or all the connected devices. The remote power switch shall provide web based troubleshoot and monitoring capabilities. This work shall include test and performance verification, and incidentals necessary to complete the work.

Surge Protection Devices, SPD

(a) SPD for Data, Communications, Video, and 24V Power Cable

Surge Protective Devices, SPDs, for data, communications, 24V power, and video equipment shall be in accordance with 105.03. SPD's shall be used for the protection of all data, communications, video circuits, and low voltage power at 24V or less including POE cables from the effects of lightning induced currents and other transients.

1. SPD for Data and Communications Cable

Plug-in jack or terminal connected SPDs shall protect all low-voltage signal pairs. The SPDs shall meet or exceed the following minimum requirements:

- a. The SPDs shall be UL Listed 497B.
- b. The protectors shall suppress a peak surge current of up to 10K amps.
- c. The protectors shall have a response time less than 5 nanoseconds.
- d. The protector shall clamp the voltage between the two wires at 8 volts and clamp the voltage between each wire and ground at 50 volts.
- e. The first stage of protection shall be a three-element gas discharge tube, and the second stage shall consist of silicon clamping devices.
- f. It shall be possible to replace the protector using standard tools.
- g. The SPD housing shall be metallic and be grounded.

2. SPD for 24V Power Cable

Cables carrying 24V power shall be equipped with surge protectors that meet or exceed the following minimum characteristics:

- a. The clamping voltage shall be 50V.
- b. The response time shall be five nanoseconds or less.
- c. Bipolar silicon avalanche diode technology shall be used in a single stage device.
- d. The module shall dissipate a minimum of 50 Joules.
- e. The module shall pass signals from DC to 80 MHz with less than 0.5 dB insertion loss.

3. Installation

The Contractor shall examine conditions for compliance with requirements for installation tolerances, characteristics, and other conditions affecting performance of transient voltage surge suppressors. The Contractor shall not proceed with installation until unsatisfactory conditions have been corrected.

Conductors between the SPD and the point of attachment shall be kept as straight and short as possible.

The SPDs ground shall be bonded to the cabinet's grounding bar. The Contractor shall ground each SPD's enclosure.

The Contractor shall tighten electrical connectors and terminals in accordance with the manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, the Contractor shall use those specified in UL 486A.

The Contractor shall install an appropriate SPD at all data, communication, video, and low voltage connections or termination.

(b) SPD for Power at Line Voltage

1. Electrical Requirements

SPD for circuits and equipment rated at 1,000V or less are used for the protection of all electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and capacitive load switching.

SPD for circuits and equipment rated at 1,000V or less shall be in accordance with Motorola R-56, 807.02, 922.07, and the following:

- a. The device shall be UL 1449, 2nd Edition, or later revision listed or recognized. Devices may also conform to the international CE certification mark.
- b. SPDs shall be selected based on the operating voltage and number of phases of the circuits to be protected.
- c. The minimum pulse life or durability requirements and the voltage protection level shall be as specified in Table 9-2 of R-56 for the respective Maximum Continuous Operating Voltage, MCOV, and Type listed.
- d. Each module shall have indicator lamps visible from the front of the device showing that the module has power applied and that the protection integrity has not been compromised. The SPDs shall include a set of form "C" dry contacts for remote alarm reporting capability, except for Type 3 devices. This set of contacts shall operate when there is an input power failure or the integrity of any module has been compromised. This contact set shall be isolated from the AC power circuitry to safeguard the alarm circuit or reporting device in case of a catastrophic event.
- e. Each module or subassembly shall be modular in design to allow for easy field replacement.

- f. Module components shall not be encapsulated.
- g. Maximum Continuous Operating Voltage: 110 percent of nominal system operating voltage.

The Contractor shall provide electrically operated equipment that is listed and labeled as defined in the NEC, Article 100. Listing and labeling shall comply with; NFPA 70, UL 1283, UL 1449, ANSI C62.41 and ANSI C62.45.

SPDs shall be manufactured in the U.S.A. by a manufacturer engaged in the design and manufacture of such devices for a period of at least 2 years.

Subject to compliance with requirements, the Contractor shall provide products by one of the following:

- a. EFI Electronics, 65 AR for 120/240 volt, Omni-Phase OSW for 240/480 volt.
- b. Advanced Protection Technologies, Inc.
- c. Transvector
- d. Polyphaser
- e. Innovative Technology, Inc.
- f. Current Technology.

Common Mode AC power SPDs shall not be utilized. This may constitute a personnel safety hazard and could constitute an NFPA 70 violation by creating a neutral-ground bond at a location other than at the main service disconnect. Common Mode surge suppression devices may be used on telephone or data circuits.

Type 1 Panel Type Surge Protective Devices. Specific requirements shall be as follows:

- a. The device shall consist of primary modules using Silicon Avalanche Diode, SAD, technology and secondary modules using Metal Oxide Varistor, MOV, technology.
- b. A SAD and MOV module shall be installed from each phase conductor to the neutral conductor, L-N, Normal Mode.
- c. Module or devices of any type shall not be connected between any phase conductor and the equipment grounding conductor or ground, L-G, Common Mode.
- d. The primary modules shall consist of a SAD module providing 250 Joules per phase, per polarity, minimum energy absorption.
- e. The secondary module shall consist of a MOV module, with 5000 Joules per phase of energy absorption. This module shall be equal to, and have the same specifications and performance characteristics, as modules utilized in the Type 1A and 2 devices.
- f. True sine wave tracking with let through voltage no greater than L-N 70V, L-L 80V, L-G 90, and N-G 90V.

Type 3 Individual Equipment Surge Protective Devices. Specific requirements shall be as follows:

- a. Install Type 3 SPDs on each critical load when the load requires greater than 10 ft of conductor length from the panel with Type 1 SPDs. Where the load requires between 10 ft and 50 ft of conductor length for a Type 1 device, a Type 3 device is optional. Where the load requires greater than 50 ft of conductor length or 25 ft of circuit length from the Type 1 device, a Type 3 device is required.
- b. All individual equipment devices shall provide a minimum of 25 Joules using SAD technology.
- c. Normal Mode, L-N, circuit protection.
- d. Individual SPDs with the plug manufactured as a part of the device shall be plugged into a single simplex receptacle outlet and shall incorporate a single simplex receptacle outlet for the load connection. Individual plug-in units with a duplex receptacle outlet shall not be used.
- e. Multi-receptacle outlet strips with SPDs may also incorporate data circuit secondary protection devices within the same housing.
- f. Multi-receptacle outlet strips SPDs shall incorporate an independent grounding point on the exterior of the device. This point shall be rated for attachment of a #6 AWG equipment conductor.
- g. Multi-receptacle device housings shall be metallic and shall be provided with mounting ears, tabs or brackets. Devices may be suitable for standard EIA 19-in. rack mounting.
- h. Each device shall have an indicator lamp visible from the front of the device showing that the module has power applied and that the protection integrity has not been compromised. Alarm relay contacts to remotely report device failure may be offered but are not required.
- i. Each multiple receptacle outlet strip type device incorporating telephone or data circuit protection shall be UL 1459 and UL 497A listed or recognized. Devices may conform to the international CE certification mark.

2. Installation

The Contractor shall examine conditions for compliance with requirements for installation tolerances, power characteristics, and other conditions affecting performance of transient voltage surge suppressors. The Contractor shall not proceed with installation until unsatisfactory conditions have been corrected.

The Contractor shall install a circuit breaker sized in accordance with the manufacturer's requirements for each line connection.

The Contractor shall follow the manufacturer's installation instructions for each SPD.

Conductors between the SPD and the point of attachment shall be kept as straight and short as possible. The conductor shall be 5 ft or less in length measured terminal to terminal. In no case shall the length be longer than indicated in the manufacturer's installation instructions.

The Contractor shall connect SPD circuit in line-to-neutral configuration if a neutral conductor is available.

A Type 1 SPD ground shall be bonded to the service entrance ground where installed at a utility service point or to the panel's equipment grounding conductor. Type 2 or Type 3 SPDs shall be connected to the nearest equipment grounding conductor.

The Contractor shall ground each transient voltage surge suppressor enclosure.

The Contractor shall tighten electrical connectors and terminals according to manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, the Contractor shall use those specified in UL 486A. All components shall be installed as shown on the plans.

The Contractor shall install a Type 1 SPD at each utility service point, each circuit breaker panel, and where otherwise indicated.

The Contractor shall install a Type 3 SPD such that all permanently installed electronic equipment is protected at the receptacle, hardwired connection or other point where the equipment is connected to electric power.

Vault, ATMS

ATMS vaults for communications cable access shall be in accordance with 807.03. All vault covers shall be bolted into place to prevent accidental removal by mowing crews or other unintentional means. The cover frame shall be installed in the vault with a butyl rubber sealant in tape and coil form for a proper seal and to prevent the frame from moving out of place. The sealant shall comply with ASTM C990 for butyl rubber sealants.

The vault rings and covers shall be in accordance with 807.09 except the message displayed on the lid shall read "TRAFFIC MANAGEMENT SYSTEM". Fabrication of these vault covers shall not commence until working drawings, that the Contractor shall have submitted, have been approved by the Engineer.

Cable racks shall be provided with two modular brackets.

ATMS vaults shall be installed at the planned locations as determined by the Engineer or on the site listing.

Material surrounding the buried conduit splices and ATMS vaults shall be tamped and added in such a manner so that there are no voids or depressions formed. Conduit entrance and exit points in the new ATMS vaults shall be sealed watertight.

ATMS vaults shall be precast. The top of the vault shall be flat and level with the surrounding ground. The vault shall be placed such that final grading will provide a minimum of 4 in. of soil over the concrete box. The Contractor shall clean all applicable surfaces before installing butyl sealant on the cover frame prior to installation in the vault. Adhesive primer shall be used when moisture is present on surfaces. The Contractor shall follow the manufacturer's instructions for proper installation. When the installation is completed, all disturbed portions of the construction area shall be cleaned and any excess excavation or other materials shall be properly disposed of as soon as possible.

Cable racks shall be bolted to the vault wall. The two brackets shall be installed level to one another near the top of the racks. The coiled fiber optic cable shall be hung from the brackets and the splice closure shall be securely tie-wrapped to the top of the brackets.

Torsion-Assisted ITS Vault

The torsion-assisted ITS vault shall be precast and shall have exterior dimensions of 4 ft by 4 ft by 4 ft or shall be sized to accommodate the bend radius of the fiber, whichever is larger. If the vault will exceed the minimum 4 ft by 4 ft by 4 ft dimensions, the Contractor shall submit for approval documentation demonstrating the need for the larger vault. The cover shall be able to be bolted closed into place to prevent accidental opening by mowing crews or other unintentional means. The cover shall not be padlockable. The cover shall be torsion-assisted by a mechanical shock to aid in opening the vault after the bolts are removed. The cover shall have a kickstand to allow the cover to be secured in the open position and allow safe access to the contents of the vault. The cover frame shall be installed in the vault with a butyl rubber sealant in a tape or coil form for a proper seal to prevent the frame from moving out of place. The sealant shall comply with ASTM C990 for butyl rubber sealants.

Material surrounding torsion-assist ITS vaults shall be tamped and added in such a manner so that no voids or depressions are formed. The top of the vault shall be flat and level with the surrounding ground.

Before installing butyl rubber sealant on the cover frame, the surfaces in contact with the butyl rubber sealant shall be cleaned prior to installation in the vault. Adhesive primer shall be used when moisture is present on surfaces. Manufacturer's instructions shall be followed for proper installation.

When installation is completed, all disturbed portions of the construction area shall be cleaned. Any excess excavation or other material shall be properly disposed of.

Method of Measurement

Auxiliary BIU panels; CCTV camera; fiber optic fusion splice, fiber optic splice enclosure; fiber optic patch cable; fiber optic patch panels; handhole covers and rings; ITS, camera lowering devices; ITS, camera lowering device retrofits; ITS, camera lowering tool, retrofit; ITS field switches; ITS field switch single rack mount kits; post mounted transformers; remote power switches; service points; vault; and vault, ring and cover; will be measured by the number of units installed.

Cable of the type specified and conduit pull tape will be measured by the linear foot. Tracer wire of the type and size specified will be measured by the linear foot.

Conduit, controller cabinet foundation, and traffic signal system repairs will be measured in accordance with 805.15.

Light poles, lighting foundations, and wire will be measured in accordance with 807.18

Existing camera lowering systems to be removed will be measured by the number of systems removed.

Electrical identification; reinforcing bars; service point, ATMS, connection allowance; and transient voltage surge suppressors will not be measured for payment.

Basis of Payment

If specified as pay items, auxiliary BIU panels; CCTV camera; CCTV support tower; CCTV support tower foundation; fiber optic fusion splice; fiber optic patch cable; fiber optic patch panels; fiber optic splice enclosure; fiber optic strand splice; handhole covers and rings; ITS, camera lowering device; ITS, camera lowering device, retrofit; ITS, camera lowering tool, retrofit; ITS field switches; ITS field switch single rack mount kits; microwave detectors; remote power switches; post mounted transformers; service points; vaults; and vault rings and covers; will be paid for at the contract unit price per each.

Cable of the type specified and conduit pull tape will be paid for at the contract unit price per linear foot. Tracer wire of the type and size specified will be paid for at the contract unit price per linear foot.

Conduit and controller cabinet foundations will be paid for in accordance with 805.16, except as modified herein.

Controller cabinet foundations will be paid for in accordance with 805.16.

Light poles, lighting foundations, and wire will be paid for in accordance with 807.19.

The removal of ITS camera lowering devices will be paid for at the contract unit price per each.

The cost charged by a utility to provide service will be paid for from the service point, ATMS, connection allowance pay item. The Contractor shall provide the Department with copies of all invoices from the utility for determination of the amount to be paid. The total invoice amount from the utility plus a 12% administration fee will be the final pay amount.

No additional payment will be made for pulling slack fiber optic cable from nearby vaults, as required to complete a fiber optic splice to an existing cable.

Payment will be made under:

Pay Item	Pay Unit Symbol
Auxiliary BIU Panel.....	EACH
Cable Ethernet CAT6, Outdoor Rated.....	LFT

CCTV Camera.....	EACH
CCTV Support Tower.....	EACH
CCTV Support Tower Foundation.....	EACH
Conduit Pull Tape.....	LFT
Controller Cabinet Foundation, P1.....	EACH
Fiber Optic Fusion Splice.....	EACH
Fiber Optic Patch Cable, SM and MM, LC-SC, 3 ft.....	EACH
Fiber Optic Patch Panel Assembly, 96 Port.....	EACH
Fiber Optic Patch Panel Assembly, 12 Port, 1U.....	EACH
Fiber Optic Splice Enclosure.....	EACH
Fiber Optic Strand Splice.....	EACH
Handhole Cover and Ring.....	EACH
ITS, Camera Lowering Device.....	EACH
ITS, Camera Lowering Device, Remove.....	EACH
ITS, Camera Lowering Device, Retrofit.....	EACH
ITS, Camera Lowering Tool, Retrofit.....	EACH
ITS Field Switch, 3524GT-PWR+.....	EACH
ITS Field Switch, 4826GT-PWR+.....	EACH
ITS Field Switch, Single Rack Mount Kit.....	EACH
ITS, Remote Power Switch.....	EACH
ITS, TPIMS Information Panel.....	EACH
Microwave Detector.....	EACH
Microwave Detector Cable.....	LFT
Service Point, ATMS, 120/240V, Overhead.....	EACH
Service Point, ATMS, 480V, Overhead.....	EACH
Service Point, ATMS, 120/240V, Underground.....	EACH
Service Point, ATMS, 480V, Underground.....	EACH
Service Point, ATMS, Connection Allowance.....	DOL
Service Point, ATMS, Subpanel.....	EACH
Tracer Wire XHHW, 1 T/C No. 6, Copper, Green Jacket...	EACH
Transformer, 25 kVA, Post Mounted.....	EACH
Torsion-Assisted ITS Vault	
Vault, ATMS.....	EACH
Vault, Ring and Cover.....	EACH

The cost of all other material and hardware necessary to accomplish the auxiliary BIU panel installation shall be included in the cost of auxiliary BIU panel.

The cost of the CCTV assembly shall include the color camera, zoom lenses, environmental enclosure, pan/tilt unit, housing, dome, parapet mount, and all mounting hardware, support arms, connections, or two Ethernet CAT6 cables, lowering device, and incidentals necessary to complete the work shall be included in the cost of CCTV assembly.

The cost of all fittings, bends, sweeps, expansion joints, installation equipment, trenching, backfilling, epoxy adhesive kits, fusion splices, couplers, connectors, conduit brackets and hangers, lag screws, lag screw holes, epoxy patch for concrete holes, attachment hardware, warning tape, stormwater control, restoring disturbed areas, other supporting equipment, junction boxes for structure mounted conduit, labor, and all other incidentals necessary for installation shall be included in the cost conduit.

The costs of the hardware, conduit, bolts and epoxy necessary to modify the controller cabinet foundation, electrical connections, and all required labor and incidentals shall be included in the cost of controller cabinet foundation.

The cost of the patch panel connections, network card connections, and any other necessary equipment shall be included in the cost of fiber optic patch cable.

The cost of appropriate mounting hardware, terminating each fiber optic strand, labor, materials, labor, equipment, transportation, placement, and any other incidental materials necessary to complete the work shall be included in the cost of fiber optic patch panel assembly.

The cost of pulling slack cable, incidentals, and all testing and performance verification shall be included in the cost of the fiber optic splice.

The cost of all concrete and other materials, if required, and the cost of removing an existing damaged handhole cover and ring shall be included in the cost of handhole cover and ring.

The cost of all items necessary to complete a camera lowering system, including the contact unit, self-aligning divided support arm, an adapter for attachment to the tower, a camera connection box, lowering tools, cable supports and guides, appropriate mounting hardware, labor, and any other incidental materials necessary to complete the work shall be included in the cost of ITS camera lowering device.

The cost of all items necessary to complete a camera lowering system, including the contact unit, self-aligning divided support arm, an adapter for attachment to the tower, a camera connection box, lowering tools, cable supports and guides, appropriate mounting hardware, labor, and any other incidental materials necessary to complete the work shall be included in the cost of ITS camera lowering device retrofit.

The cost of the mounting hardware, rack mount kit, all cabling, power supplies, and incidentals necessary to complete the work shall be included in the cost of ITS field switch.

The cost of all hardware, software, cables, mounting, cable ties, grommets, 110VAC/24VDC power converter, RS422/RS232 serial converter, surge suppressor, setup, diagnostics, and demonstration of performance requirements shall be included in the cost of microwave detector. The microwave vehicle detector pay item does not include the detector cabinet, pole, detector cable, or pole foundation.

The cost of terminations, connections, service conductors, circuit breakers, ground rods, ground wires, fittings, switches, service cabinets, utility current transformer cabinets, weatherheads, meter sockets, cables, conduits down to first below grade bend, poles, aluminum channels, braces, and mounting surfaces, and other miscellaneous items shall be included in the cost of the service point.

The cost of wire nuts or connectors shall be included in the cost of tracer wire.

The cost of materials, labor, equipment, transportation, placement, incidentals, terminations, connections, conduit risers, fittings, foundations, posts, and any removal of the old transformer or modification or repairs to an existing post to mount the new transformer shall be included in the cost of post mounted transformer.

The cost of utility coordination, and all work required to properly

return full service shall be included in the cost of the service point, connection allowance.

The cost of furnishing and installation of a new vault, a bolt down cover, cable racks and brackets, tie-wrapping the splice closure, butyl sealant, and all other accessories, grading, labor, equipment, transportation, placement, and re-seeding necessary for a complete installation shall be included in the cost of vault.

The cost of furnishing and installation of a bolt down cover, butyl sealant, and all other accessories, grading, labor, equipment, transportation, placement, and re-seeding necessary for a complete installation shall be included in the cost of vault, ring and cover.

The cost of electrical identification, excavation, backfill, final cleanup, padlocks, the preparation and transmittal of working drawings, and transient voltage surge suppressors shall be included in the cost of the pay items in this section.
