MISSOURI DEPARTMENT OF TRANSPORTATION
BID GUIDELINES AND DOCUMENTATION

THIS IS NOT AN ORDER

REQUEST FOR BID

It is the vendor's responsibility to read and comply with all conditions, specifications, and instructions outlined in this document. This document and any subsequent attachments shall supersede all confirmation forms, receipts, or any other paperwork needed to secure materials, equipment, or services.

TODAY'S DATE: 05-29-2008	**BID DUE BY (DATE AND TIME): 06-04-2008 BY 1:00 PM**	F.O.B. REQUIREMENTS: DESTINATION (SEE DELIVERY LOCATIONS BELOW)
TO BE DELIVERED BY: JUNE 15, 2008	**BID #: B4-08-005** THIS BID # SHOULD BE REFERENCED ON ALL MAILING LABELS, ENVELOPES, AND ANY OTHER CORRESPONDENCE.	BUYER NAME: ROBIN WARREN 816-622-0054

District Mailing Address:	Delivery Locations:
Missouri Department of Transportation – District 4 General Services Procurement Division 600 NE Colbern Road Lee's Summit, MO 64064	9101 E 40TH Terrace Kansas City, MO 64133

ALL BIDS MUST BE EXTENDED AND TOTALED. DELIVERY TIME MUST BE LISTED

Quantity	U/M	DESCRIPTION (including size and/or part #'s)	UNIT PRICE	UNIT PRICE EXTENSION	DELIVERY TIME
10	Ea	Adaptive Traffic Signal Control Systems			

Bid shall consist of furnishing 10 four-camera video detection systems that detects vehicles by video processing images and providing detection outputs to a signal controller per Missouri Standard Specification Section 902. In addition, the system shall include InSync Traffic Adaptive System.

TOTAL ORDER EXTENSION	$

VENDOR NOTES

Missouri Department of Transportation purchase orders must be issued to the invoicing company/address. If the invoicing company/address will be different from that listed in the vendor information section (below), the vendor must specify the "remit to" company/address in the vendor notes section (above).

VENDOR INFORMATION

Vendor Name/Mailing Address:	Vendor Contact Information (including area codes): Phone #: Fax #: Cellular #:		
Printed Name and Title of Responsible Officer or Employee:	Signature:		
Is your company registered/certified with the State of Missouri as a (please circle):			
	MINORITY BUSINESS ENTERPRISE (MBE) ?	YES	NO
	WOMEN BUSINESS ENTERPRISE (WBE) ?	YES	NO
Would your company like information on becoming a registered/certified MBE/WBE vendor?		YES	NO

All responses to this Request for Bid MUST be submitted on this form and all pages MUST be returned to the Buyer listed above at the District mailing address shown.

PREFERENCE IN PURCHASING PRODUCTS

DATE: _____

The bidders attention is directed to Section 34.076 RsMO 1986 which gives preference to Missouri corporations, firms, and individuals when letting contracts or purchasing products.

Bids/Quotations received will be evaluated on the basis of this legislation.

All vendors submitting a bid/quotation must furnish <u>ALL</u> information requested below.

FOR CORPORATIONS:

State in which incorporated: _____

FOR OTHERS:

State of domicile: _____

FOR ALL VENDORS:

List address of Missouri offices or places of business:

_____

_____

_____

_____

_____

_____

_____

THIS SECTION MUST BE COMPLETED AND SIGNED:

FIRM NAME: _____

ADDRESS: _____

CITY: _____ **STATE:** _____ **ZIP:** _____

BY (signature required): _____

Federal Tax I.D. #: _____ **if no Federal Tax I.D. # - list Social Security #:** _____

NOTE: For bid/quotation to be considered, the "Preference in Purchasing Products" form must be on file in the General Services (Procurement) Division and must be dated in the current calendar year.

MISSOURI DOMESTIC PRODUCTS PROCUREMENT ACT

The bidder's attention is directed to the Missouri Domestic Products Procurement Act, Sections 34.350 to 34/359, RsMO, which requires all manufactured goods or commodities used or supplied in the performance of this contract or any subcontract to be manufactured or produced in the United States.

Section 34.355, RsMO, requires the vendor or contractor to certify his compliance with Section 34.353 and, if applicable, Section 34.359, RsMO, at the time of bidding **and** prior to payment. Failure to comply with Section 34.353, RsMO, during the performance of the contract **and** to provide certification of compliance prior to payment will result in nonpayment for those goods or commodities.

Section 34.353.2, RsMO, specifies that it does not apply where the total contract is less than Twenty-Five Thousand Dollars ($25,000.00). If your total bid is Twenty-Five Thousand Dollars ($25,000.00) or more, you **must** complete this form as directed below.

Failure to complete and return this document with this bid will cause the State to presume the manufactured goods or products listed in the bid are not manufactured or produced in the United States, and the bid will be evaluated on that basis. Please read the certification appearing below on this form.

[ ] If all the goods or products specified in the attached bid which the bidder proposes to supply to the State shall be manufactured or produced in the "United States" as defined in Section 34.350, RsMO, check the box at left.

[ ] If only one item of any particular goods or products specified in the attached bid is manufactured or produced in the "United States" as defined in Section 34.350, RsMO, check the box at left and list the items (or item number) here:

_____

_____

[ ] If any or all of the goods or products specified in the attached bid which the bidder proposes to supply to the State are **not** manufactured or produced in the "United States" as defined in Section 34.350, RsMO, then: (a) check the box at left; (b) list below, by item (or item number), the country other than the United States where each good or product is manufactured or produced; and (c) check the boxes to the left of the paragraphs below if applicable and list the corresponding items (or item numbers) in the spaces provided.

Item (or item number)	Location Where Item Manufactured or Produced

(attach an additional sheet if necessary)

[ ] The following specified goods or products cannot be manufactured or produced in the United States in sufficient quantities or in time to me the contract specifications. Items (or item numbers): _____

_____

[ ] The following specified goods or products must be treated as manufactured or produced in the United States, in accordance with an existing treaty, law, agreement, or regulation of the United States, including a treaty between the United States and any foreign country regarding export-import restrictions or international trade. Items (or item numbers): _____

_____

CERTIFICATION

By submitting this document, completed as directed above, with a bid, the bidder certifies under penalty of making false declaration (Section 575.060, RsMO) that the information contained in this document if true, correct and complete, and may be relied upon by the State in determining the bidders qualifications under and in compliance with the Missouri Domestic Products Procurement Act.

The bidder's failure to complete and return this document with the bid as directed above will cause the State to presume the manufactured goods or products listed in the bid are not manufactured or produced in the United States, and the bid will be evaluated on that basis pursuant to Section 34.353.3(2), RsMO.

STANDARD SOLICITATION PROVISIONS

a. The Missouri Department of Transportation (MoDOT) reserves the right to reject any or all bids/quotes/proposals, and to accept or reject any items thereon, and to waive technicalities. In case of error in the extension of prices in the bid/quote/proposal, unit prices will govern.

b. All bids/quotes/proposals must be signed with the firm name and by a responsible officer or employee. Obligations assumed by such signature must be fulfilled.

c. By virtue of statutory authority, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, made or grown, within the State of Missouri.

d. Time of delivery is a part of the consideration and, if not otherwise stated in the solicitation documents, must be stated in definite terms by the Bidder/Offeror and must be adhered to. If time varies on different items, the Bidder/Offeror shall so state.

e. If providing bids/quotes/proposals for commodities, the Bidder/Offeror will state brand or make on each item. If bidding or proposing other than the make, model or brand specified, the manufacturer's name, model number or catalog number must be given.

f. **For bids/proposals of $25,000** or more, no bids/proposals by telephone, telegram or telefax will be accepted.

g. The date specified for the returning of bids/quotes/proposals is a firm deadline and all bids/quotes/proposals must be received at the designated office by that time. The Department does not recognize the U.S. Mail, Railway Express Agency, Air Express, or any other organization, as its agent for purposes of accepting proposals. All proposals arriving at the designated office after the deadline specified will be rejected.

GENERAL TERMS AND CONDITIONS

General Performance

a. This work is to be performed under the general supervision and direction of the Missouri Department of Transportation (MoDOT) and, if awarded any portion of the work, the Contractor agrees to furnish at his own expense all labor and equipment required to complete the work, it being expressly understood that this solicitation is for completed work based upon the price(s) specified and is not a solicitation for rental of equipment or employment of labor by MoDOT, and MoDOT is to have no direction or control over the employees used by the Contractor in performance of the work.

Deliveries

a. Unless otherwise specified on the solicitation documents or purchase order, suppliers shall give at least 24 hours advance notice of each delivery. Delivery will only be received between the hours of 8:00 a.m. to 3:00 p.m., Monday through Friday. Material arriving after 3:00 p.m. will not be unloaded until the following workday. No material will be received on Saturday, Sunday or state holidays.

b. If the prices bid herein include the delivery cost of the material, the Contractor agrees to pay all transportation charges on the material as FOB - Destination. Freight costs must be included in the unit price bid and not listed as a separate line item.

c. Any demurrage is to be paid by the Contractor direct to the railroad or carrier.

Nondiscrimination

a. The Contractor shall comply with the Regulations relative to nondiscrimination in federally-assisted programs of the Department of Transportation, Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

b. All solicitations either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials or leases of the Contractor's obligations under this contract and the Regulations, will be relative to nondiscrimination on the grounds of race, color, or national origin.

1) Sanctions for Noncompliance: In the event of the Contractor's noncompliance with the nondiscrimination provisions of this contract, MoDOT shall impose such contract sanctions as it or the Federal Highway Administration may determine to be appropriate, including, but not limited to:

i. withholding of payments to the Contractor under the contract until the Contractor complies, and/or,

ii. cancellation, termination or suspension of the contract, in whole or in part.

Contract/Purchase Order

a. By submitting a bid/quote/proposal, the Bidder/Offeror agrees to furnish any and all equipment, supplies and/or services specified in the solicitation documents, at the prices quoted, pursuant to all requirements and specifications contained therein.

b. A binding contract shall consist of: (1) the solicitation documents, amendments thereto, and/or Best and Final Offer (BAFO) request(s) with any changes/additions, (2) the Contractor's proposal and/or submitted pricing, and (3) the MHTC's acceptance of the proposal and/or bid by purchase order or post-award contract.

c. A notice of award does not constitute an authorization for shipment of equipment or supplies or a directive to proceed with services. Before providing equipment, supplies and/or services, the Contractor must receive a properly authorized purchase order and/or notice to proceed.

d. The contract expresses the complete agreement of the parties and performance shall be governed solely by the specifications and requirements contained therein. Any change, whether by modification and/or supplementation, must be accomplished by a formal contract amendment signed and approved by and between the duly authorized representative of the Contractor and the duly authorized representative of the MHTC, by a modified purchase order prior to the effective date of such modification. The Contractor expressly and explicitly understands and agrees that no other method and/or no other document, including correspondence, acts, and oral communications by or from any person, shall be used or construed as an amendment or modification.

Subcontracting

a. It is specifically understood that no portion of the material or any interest in the contract, shall be subcontracted, transferred, assigned or otherwise disposed of, except with the written consent of MoDOT. Request for permission to subcontract or otherwise dispose of any part of the work shall be in writing to MoDOT and accompanied by documentation showing that the organization which will perform the work is particularly experienced and

equipped for such work.

b. Consent to subcontract or otherwise dispose of any portion of the work shall not be construed to relieve the Contractor of any responsibility for the production and delivery of the contracted work and the completion of the work within the specified time.

c. All payments for work performed by a subcontractor shall be made to the Contractor to whom the contract was awarded and the purchase order issued.

Invoicing and Payment

a. MoDOT is exempt from paying Missouri Sales Tax, Missouri Use Tax and Federal Excise Tax. However, the Contractor may themselves be responsible for the payment of taxes on materials they purchase to fulfill the contract. A Federal Excise Tax Exemption Certificate will be furnished to the successful Bidder/Offeror upon request.

b. Each invoice should be itemized in accordance with items listed on the purchase order and/or contract. The statewide financial management system has been designed to capture certain receipt and payment information. Therefore, each invoice submitted must reference the purchase order number and must be itemized in accordance with items listed on the purchase order. Failure to comply with this requirement may delay processing of invoices for payment.

c. Unless otherwise provided for in the solicitation documents, payment for all equipment, supplies, and/or services required herein shall be made in arrears. The Missouri Highways and Transportation Commission (MHTC) shall not make any advance deposits.

d. The MHTC assumes no obligation for equipment, supplies, and/or services shipped or provided in excess of the quantity ordered. Any authorized quantity is subject to the MHTC's rejection and shall be returned at the Contractor's expense.

e. The MHTC reserves the right to purchase goods and services using the state-purchasing card.

Applicable Laws and Regulations

a. The contract shall be construed according to the laws of the State of Missouri. The Contractor shall comply with all local, state, and federal laws and regulations related to the performance of the contract.

b. The Contractor must be registered and maintain good standing with the Secretary of State of the State of Missouri and other regulatory agencies, as may be required by law or regulations. Prior to the issuance of a purchase order and/or notice to proceed, the Contractor may be required to submit to MoDOT a copy of their current Authority Certificate from the Secretary of State of the State of Missouri.

1) Prior to the issuance of a purchase order and/or notice to proceed, all **out-of-state** Contractors **providing services** within the state of Missouri must submit to MoDOT a copy of their current Transient Employer Certificate from the Department of Revenue, in addition to a copy of their current Authority Certificate from the Secretary of State of the State of Missouri.

c. The exclusive venue for any legal proceeding relating to or arising, out of the contract shall be in the Circuit Court of Cole County, Missouri.

Executive Order

a. The Contractor shall comply with all the provisions of Executive Order 07-13, issued by the Honorable Matt Blunt, Governor of Missouri, on the sixth (6^{th}) day of March, 2007. This Executive Order, which promulgates the State of Missouri's position to not tolerate persons who contract with the state engaging in or supporting illegal activities of employing individuals who are not eligible to work in the United States, is incorporated herein by reference and made a part of this Agreement.

1) "By signing this Agreement, the Contractor hereby certifies that any employee of the Contractor assigned to perform services under the contract is eligible and authorized to work in the United States in compliance with federal law."

2) In the event the Contractor fails to comply with the provisions of the Executive Order 07-13, or in the event the Commission has reasonable cause to believe that the contractor has knowingly employed individuals who are not eligible to work in the United States in violation of federal law, the Commission reserves the right to impose such contract sanctions as it may determine to be appropriate, including but not limited to contract cancellation, termination or suspension in whole or in part or both.

3) The Contractor shall include the provisions of this paragraph in every subcontract. The Contractor shall take such action with respect to any subcontract as the Commission may direct as a means of enforcing such provisions, including sanctions for noncompliance.

Preferences

a. In the evaluation of bids/quotes/proposals, preferences shall be applied in accordance with Chapter 34 RSMo. Contractors should apply the same preferences in selecting subcontractors.

b. By virtue of statutory authority, RSMo. 34.076 and 34.350 to 34.359, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, made or grown within the State of Missouri. Such preference shall be given when quality is equal or better and delivered price is the same or less.

1) If attached, the document entitled **"PREFERENCE IN PURCHASING PRODUCTS"** should be completed and returned with the solicitation documents.

2) If attached, the document entitled **"MISSOURI DOMESTIC PRODUCTS PROCUREMENT ACT"** should be completed and returned with the solicitation documents**. Applies if bid is Twenty-Five Thousand Dollars ($25,000.00) or more.**

c. In the event of a tie of low bids, the MHTC reserves the right to establish the method to be used in determining the award

Remedies and Rights

a. No provision in the contract shall be construed, expressly or implied, as a waiver by the MHTC of any existing or future right and/or remedy available by law in the event of any claim by the MHTC of the Contractor's default or breach of contract.

b. The Contractor agrees and understands that the contract shall constitute an assignment by the Contractor to the MHTC of all rights, title and interest in and to all causes of action that the Contractor may have under the antitrust laws of the United States or State of Missouri for which causes of action have accrued or will accrue as the result of or in relation to the particular equipment, supplies, and/or services purchased or produced by the Contractor in the fulfillment of the contract with the MHTC.

c. In the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request MoDOT to enter into such litigation to protect the interests of the MHTC, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

Cancellation of Contract

a. The MHTC may cancel the contract at any time for a material breach of contractual obligations or for convenience by providing the Contractor with written notice of cancellation. Should the MHTC exercise its right to cancel the contract for such reasons, cancellation will become effective upon the date specified in the notice of cancellation sent to the Contractor.

b. If the MHTC cancels the contract for breach, the MHTC reserves the right to obtain the equipment, supplies, and/or services to be provided pursuant to the contract from other sources and upon such terms and in such manner as the MHTC deems appropriate and charge the Contractor for any additional costs incurred thereby.

Bankruptcy or Insolvency

a. Upon filing for any bankruptcy or insolvency proceeding by or against the Contractor, whether voluntary or involuntary, or upon the appointment of a receiver, trustee, or assigned the benefit or creditors, the Contractor must notify MoDOT immediately. Upon learning of any such actions, the MHTC reserves the right, at its sole discretion, to either cancel the contract or affirm the contract and hold the Contractor responsible for damages.

Inventions, Patents, and Copyrights

a. The Contractor shall defend, protect, and hold harmless the MHTC, its officers, agents, and employees against all suits of law or in equity resulting from patent and copyright infringement concerning the Contractor's performance or products produced under the terms of the contract.

Inspection and Acceptance

a. No equipment, supplies, and/or services received by MoDOT pursuant to a contract shall be deemed accepted until MoDOT has had reasonable opportunity to inspect said equipment, supplies, and/or services.

b. All equipment, supplies, and/or services which do not comply with the specifications and/or requirements or which are otherwise unacceptable or defective may be rejected. In addition, all equipment, supplies, and/or services which are discovered to be defective or which do not conform to any warranty of the Contractor upon inspection (or at any later time if the defects contained were not reasonably ascertainable upon the initial inspection) may be rejected.

c. The MHTC reserves the right to return any such rejected shipment at the Contractor's expense for full credit or replacement and to specify a reasonable date by which replacements must be received.

d. The MHTC's right to reject any unacceptable equipment, supplies, and/or services shall not exclude any other legal, equitable or contractual remedies the MHTC may have.

Warranty

a. The Contractor expressly warrants that all equipment, supplies, and/or services provided shall: (1) conform to each and every specification, drawing, sample or other description which was furnished to or adopted by MoDOT, (2) be fit and sufficient for the purpose expressed in the solicitation documents, (3) be merchantable, (4) be of good materials and workmanship, and (5) be free from defect.

b. Such warranty shall survive delivery and shall not be deemed waived either by reason of the MHTC's acceptance of or payment for said equipment, supplies, and/or services.

Status of Independent Contractor

a. The Contractor represents itself to be an independent Contractor offering such services to the general public and shall not represent itself or its employees to be an employee of the MHTC. Therefore, the Contractor shall assume all legal and financial responsibility for taxes, FICA, employee fringe benefits, workers' compensation, employee insurance, minimum wage requirements, overtime, etc., and agrees to indemnify, save and hold the MHTC, its officers, agents and employees harmless from and against any and all losses (including attorney fees) and damage of any kind related to such matters.

Indemnification

a. The Offeror shall defend, indemnify and hold harmless the Commission, including its members and department employees, from any claim or liability whether based on a claim for damages to real or personal property or to a person for any matter relating to or arising out of the Offeror's performance of its obligations under this Agreement.

SPECIAL TERMS AND CONDITIONS

Required Specifications

a. All materials, equipment, and/or services bid upon must comply with the attached MoDOT Specification #902 and any other provisions outlined in the solicitation documents.

Liquidated Damages

a. In the event the successful Contractor fails to deliver the material within the time specified, the Department and the public will sustain damages because of such delay in delivery, the exact extent of which would be difficult to ascertain, and in order to liquidate such damage in advance it is agreed that the **sum of one-hundred dollars ($100.00) per day, per item,** for each assessable calendar day on which the delivery has not been completed, is reasonable and the best estimate which the parties can arrive at as liquidated damages, and it is therefore agreed that said amount will be withheld from payments due the Contractor or otherwise collected from the Contractor as liquidated damages.

b. **Saturdays, Sundays, holidays and days whereas the Department has suspended work** shall not be assessable days.

SECTION 902

TRAFFIC SIGNALS

902.1 Description. This work shall consist of furnishing and installing traffic signal equipment and material as shown on the plans. All work shall be in accordance with NEC, NESC and NEMA standards.

902.2 General. Existing traffic signals shall be maintained in effective operation by the contractor, except for shutdowns approved by the engineer for alterations or final removal. After any modifications have been made or after work is begun on an existing signal installation, the contractor shall maintain the signals in accordance with Sec 902.21. The contractor shall notify local traffic control agencies at least two days, excluding weekends and state holidays, prior to operational shutdown of any traffic signal. The contractor shall notify the engineer at least two days, excluding weekends and state holidays, prior to disconnecting existing vehicle or pedestrian detection. All traffic signal equipment that the contractor uses or installs on the project, whether furnished by the Commission or the contractor, either on a temporary or permanent basis, shall, upon installation or upon initial use by the contractor, be operated and maintained by the contractor until the project is complete and accepted. Any malfunction of an existing signal installation resulting from the contractor's operation, regardless of the nature of the work, shall be corrected at the contractor's expense in accordance with Sec 902.21. Signal timing will be provided to the contractor by the engineer. Programming of the controller will be the responsibility of the contractor, except when waived by the engineer. If any adjustments are required to the operation of an existing signal installation due to the contractor's operation, the contractor shall provide a minimum of two working days notice to the engineer.

902.3 Temporary Traffic Signals. Installation of temporary traffic signals shall consist of furnishing and installing poles for span wire signals, span and tether wires, control and power cable, power supply and connection to a power source, the controller, signal heads, detectors, luminaires, and all mounting hardware, unless specified otherwise. Maintenance of the installation and all other equipment and material necessary to provide the temporary installation will be the responsibility of the contractor. If the temporary traffic signal installation is not shown on the plans, the contractor shall submit a plan to the engineer for approval prior to the installation of temporary signals. Any existing or Commission furnished signal equipment to be used in the temporary signal shall be shown on the temporary signal plan. Temporary signals shall have the signal heads covered until placed in operation. A minimum of two signal faces, in accordance with Sec 1092, shall be oriented toward each street approach positioned a minimum of 8 feet (2.5 m) apart, center to center, and a minimum of 16 feet (5 m) above the surface of the traveled way to the bottom of the backplate. Existing signals shall not be taken out of operation until the temporary signals are ready for operation and approved by the engineer. A flashing operation shall be used during shutdown of the temporary signals.

902.3.1 All temporary signal equipment shall be removed by the contractor after the new installation is in operation, or as directed by the engineer. Contractor furnished equipment that will become the property of the Commission shall be of new stock and shall meet all applicable specifications. Contractor furnished equipment that will remain the property of the contractor may be new or used. Commission owned equipment will remain the property of the

Commission, unless specified otherwise, and shall be disposed of as shown on the plans or as directed by the engineer.

902.3.2 The contractor shall pay all electrical costs incurred by operation of the temporary signals and new signal systems until the signals are accepted for maintenance. For temporary signal installations where an existing signal power supply is not available, the contractor shall make any necessary arrangements to provide power to the temporary signals. Portable generators shall not be used to provide power to temporary signals. No direct payment will be made for power costs. All wire and cable for temporary signals shall be suspended overhead with proper clearance or buried a minimum of 18 inches (450 mm) underground.

902.3.3 Temporary signal installations shall be installed to meet the construction schedule. The contractor shall provide a minimum of two working days notice to the engineer prior to the signal turn-on. The contractor shall maintain the signals in proper operating condition, in accordance with Sec 902.21. Any damage to the traffic signal installation from any cause whatsoever shall be repaired by the contractor at the contractor's expense.

902.4 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section/Specification
Concrete	501
Galvanized Coating of Traffic Signal Posts and Appurtenances	712
High-Strength Bolts, Nuts and Washers	712
Low-Carbon Steel Bolts, Nuts and Washers	712
Structural Low Alloy Steel	712
Luminaires	901
Signs	903
Reinforcing Steel for Concrete	1036
Wood Poles for Power Supplies and Temporary Installations	1050
Electrical Conduit	1060
Electrical Conductors	1061
Pull and Junction Boxes	1062
Fiber Optic Interconnect	1092
Signal Equipment	1092
Nuts for Anchor Bolts	ASTM A 563, Grade C, D or DH or ASTM A 194, Grade 2 or 2H
Stainless Steel Bolts, Screws and Washers	ASTM A 193, Grades B5, B6, B7 or B16
Stainless Steel Nuts	ASTM A 194

902.4.1 Bolts, nuts and washers, except stainless steel, shall be galvanized in accordance with AASHTO M 232 (ASTM A 153), Class C or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695), Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils (150 µm). Anchor bolts shall have a minimum yield strength of 55,000 psi (380 MPa) and a minimum elongation of 14 percent in 2 inches (50 mm) or 12 percent in 8 inches (200 mm). For anchor bolts and nuts, and for high strength bolts and nuts, except those in accordance with AASHTO M 164, the contractor shall furnish to the engineer a test report certified to be the last completed set of mechanical tests for each size in each shipment. For high strength bolts and nuts in accordance with AASHTO M 164, the contractor shall furnish a copy of the manufacturer's inspection test report for each production lot or shipping lot furnished to the engineer and shall certify the bolts furnished are in

accordance with the requirements specified. Bolts and nuts specified to meet ASTM A 307 shall be accompanied by a manufacturer's statement that the bolts and nuts were manufactured in accordance with ASTM A 307.

902.4.2 Concrete shall be of the class specified in the contract. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Sec 501 for the specific class specified. Concrete shall be placed, finished and cured, and the entire exposed surface, including sides and top, surface sealed in accordance with Sec 703.

902.4.3 Equipment and material shall be of new stock unless the contract provides for relocation of existing units or use of units furnished by others. New equipment and material shall be the product of reputable manufacturers, shall be in accordance with Caltrans 170 Specifications, ICEA, IMSA, ITE, MUTCD, NEMA, RETMA, NEC and the regulations of the National Board of Fire Underwriters, as applicable, and shall meet the approval of the engineer.

902.4.4 The configuration and installation of equipment mounted on substation and service poles shall be in accordance with the requirements of the utility company or municipality furnishing electrical power.

902.4.5 Three copies of the list of equipment and material to be installed will be furnished to the successful bidder, along with the contract for execution. The contractor shall complete the list by writing in the name of the equipment manufacturer and catalog number of each item listed. A list of pre-approved equipment and material is available through Traffic or MoDOT's web site. Only items on the latest revision of the pre-approved list will be accepted for use. Two copies of the completed list shall be submitted to the engineer and approved by the engineer in writing before items are installed. Approval of the items on the list will not relieve the contractor of responsibility for satisfactory performance of the installation.

902.5 Signal Heads. Each signal head of one or more signal faces shall be conventional or, if designated on the plans, optically limiting. The contractor may furnish aluminum or polycarbonate signal heads. The position of signal indications shall be as specified in the contract. Each traffic signal face shall consist of a number of identical signal section housings rigidly fastened together. Signal heads shall not be painted in the field.

902.5.1 Housing, Door and Visor. If existing housings are to be combined with new housings, the new housings shall be adaptable to the existing.

902.5.2 Louvers. Louvers, if specified in the contract, shall be installed in a tunnel visor with the fins or baffles in a vertical position.

902.5.3 Hardware. Fittings shall be secured to the signal housing by a closed threaded nipple and hex nut. Cast nipples shall not be used.

902.5.4 Backplates. Stainless steel bolts, nuts and flat washers shall be used to fasten the backplate to the head. Bolt lengths shall be selected to not interfere with maintenance operations. Any connection to the top of any signal section shall be watertight.

902.5.5 Optically Limiting Signal Heads. The signal section shall be a self-contained assembly consisting of an optical unit, section housing, housing door, terminal block and necessary gaskets to ensure a weatherproof unit. The optically limiting signal head shall be capable of separate mounting or inclusion in a signal face containing two or more signal sections. If existing housings are to be combined with new housings, the new housings shall be adaptable to the existing. Each signal section shall be installed and directed and the optical

limiter masked in accordance with manufacturer's recommendations to provide indications in accordance with the plans or as directed by the engineer.

902.5.6 Painting and Finishing. All metal parts reused for modification of a signal installation shall be painted in accordance with the requirements for new material. If the painted surface of any equipment is damaged, the surface shall be repaired to the satisfaction of the engineer.

902.6 Signs. Signs for signal installations, including all material required for sign mounting, shall be furnished by the contractor. Signs shall be manufactured in accordance with Sec 903, and mounted as shown on the plans.

902.7 Posts and Mast Arms. Prior to installation, manufacturer and drawing numbers shall be submitted by the contractor to the engineer for approval in writing. Four copies of applicable pre-approved drawings shall be supplied with the poles.

902.8 Span Wire Assemblies. Span wire assemblies shall include 3/8-inch (10 mm) steel messenger wire, 1/4-inch (6 mm) tether wire, guy wire, all bolts, nuts, washers, clamps, cable straps, and other appurtenances shown on the plans or necessary for proper installation. Messenger wire shall be Class A galvanized, high-strength grade, seven-wire strand in accordance with ASTM A 475. Tether wire shall be seven-wire high-strength steel cable. Splicing of messenger and tether wires will not be permitted. Clamps shall be fabricated from low alloy steel. Steel posts for span wire assemblies shall have wire inlets and cable guides with 1-1/2 inch (38 mm) raintight insulator bushings and other features specified in the contract, and shall be in accordance with Sec 1092. Wood poles and steel posts for span wire assemblies shall be as specified in the contract and as shown on the plans. Luminaire bracket arms, if specified, will be at the contractor’s expense. Conduit, junction boxes, service entrance caps, attachment hardware or other appurtenances on the wood poles or steel posts as shown on the plans will be at the contractor’s expense.

902.9 Power Supply Assembly. The power supply assembly shall be in accordance with Sec 901.

902.10 Luminaire Control. If luminaires are specified as part of the signal conduit and wiring system on the signal posts or on separate light poles, a lighting control cabinet shall be provided and installed as shown on the plans.

902.11 Traffic Controller Assemblies.

902.11.1 Wiring. All wiring shall be insulated, stranded copper wire and shall be neatly bundled and secured with plastic cable ties. For double controller cabinets, all wiring for each intersection shall be terminated in the same compartment of the cabinet as the signal controller for that intersection. Incoming field circuits shall be routed horizontally from the conduit to the back of the cabinet, then vertically to the terminal block. All terminals shall be labeled and not be visibly obstructed. All field leads shall be identified by means of round aluminum identification tags with a minimum thickness of 0.1 mils (2.5 µm) attached to the cables with a copper wire to correspond with the plans. The outgoing signal circuits shall be of the same polarity as the line side of the power supply, and the common return of the signal circuits shall be of the same polarity as the ground side of the power supply. The power supply shall be provided through three single conductor cables. The ground side of the power supply shall be carried throughout the controller in a continuous circuit, and shall be secured to a ground bus bar in an approved manner. All field conductors shall be terminated in the controller cabinet.

902.11.2 Back Panel Wiring. All wiring on the backside of the controller back panel shall be neatly bundled and secured with plastic cable ties. Any multi-conductor cable between the

controller or auxiliary equipment and the back panel shall be contained in an expandable braided sleeve. All wiring shall be discrete insulated wires and shall be soldered directly to lugs on the back of terminal blocks and sockets. Printed circuit boards shall not be used.

902.12 Interconnect Types. The interconnect type shall be as shown on the plans.

902.12.1 Programming. The contractor shall install the system software in all computers to be used with the system as directed by the engineer, and shall program the local intersection controllers and the system master with all operating parameters and timing provided by the engineer.

902.12.2 Telephone Cable and Conduit. The telephone connection for the closed loop system will be coordinated by the engineer. The contractor shall contact the engineer a minimum of two weeks prior to the installation of the power supply assembly. The telephone network interface block shall be located on the power supply assembly. Two separate one-inch (25 mm) rigid conduits shall be installed for the telephone cable and shall be encased in the concrete base of the power supply and the base of the controller cabinet. One conduit shall be for the telephone cable from the telephone company pedestal to the power supply assembly, and the other conduit shall be from the power supply to the controller cabinet. Trenched telephone conduit may be installed parallel in the same trench as the conduit containing power cable. If telephone company cables cannot be installed at the same time as the telephone conduit, then a nylon pull string shall be installed in the conduit. Telephone cables shall not be exposed, except to facilitate connection to the telephone interface block. Telephone cables shall not be installed in the same conduit as the power cables. Any exposed conduit openings shall be filled with pliable duct sealant. The contractor shall supply the telephone cable between the telephone interface on the power supply and the telephone interface in the controller cabinet. The cable shall be a four-twisted-pair, shielded cable in accordance with local telephone company recommendations.

902.12.3 Closed Loop Interconnect. This work shall consist of furnishing, installing and testing a complete arterial master closed loop system comprised of intersections as shown on the plans. The system shall include all equipment listed or shown on the plans, and shall include any incidental items necessary for the satisfactory operation of the system.

902.12.4 Twisted Pair Interconnect. This work shall consist of furnishing, installing and testing a complete twisted pair interconnect system comprised of intersections shown on the plans. The twisted pair system shall include all equipment listed or shown on the plans and shall include any incidental items necessary for the satisfactory operation of the system.

902.12.4.1 Twisted Pair Interconnect Cable. Splices will not be permitted between controllers.

902.12.4.2 Twisted Pair Interconnect Installation. Twisted pair interconnect cable and the system shall be installed in accordance with the manufacturer's recommendations and as shown on the plans.

902.12.5 Wireless Telemetry Interconnect System. This work shall consist of furnishing, installing and testing a complete wireless interconnect system comprised of intersections shown on the plans. The wireless interconnect system shall include all equipment listed or shown on the plans and shall include any incidental items necessary for the satisfactory operation of the system. Telemetry radios and antennas shall be installed and set up in accordance with the plans, these specifications, and the manufacturer’s recommendations for a fully functioning system.

902.12.5.1 Antenna System. Antennas shall be positioned to receive maximum signal strength by adjusting the antenna direction while monitoring signal strength through the telemetry radio. Antenna mounts shall be securely fastened to the poles as shown on the plans. Antenna cable shall be installed inside metal poles and conduit as shown on the plans. External cable on poles shall not exceed 3 feet (1 m) unless approved by the engineer. Approved external cable runs exceeding 3 feet (1 m) shall be secured using manufacturer specified hangers at a maximum spacing of 3 feet (1 m). Cable terminations shall be made in accordance with the manufacturer's recommendations. Connectors shall be installed after cable has been pulled into place. Connectors outside of cabinets shall be sealed in accordance with the manufacturer's recommendations. Any holes made in metal poles shall be deburred and protected with grommets. Drip loops shall be provided between the antenna connector and the metal pole entrance or first pole clamp. Cable bends shall be in accordance with the manufacturer's specified bending radius. Antenna cable shall be continuous without splice between the antenna and the antenna surge protector in the controller cabinet.

902.12.5.2 Grounding. A separate ground rod shall be installed for each pole with an antenna. The ground rod shall be as shown on the plans and shall be installed in a pull box adjacent to the pole, where available. Ground wires shall be No. 2 AWG (35 mm^2) minimum, and shall be securely attached to the ground rod with galvanized grounding clamps. The ground wire shall be attached to the ground lug in metal poles. For wood pole mounting, the ground wire shall be attached directly to the antenna mount and securely fastened to the pole with wire clamps at 3 feet (1 m) maximum spacing. Copper compression lugs shall be used to attach the ground wire to ground lugs in poles or on antenna mounts.

902.12.6 Fiber Optic Interconnect System. All system equipment shall be installed in accordance with the plans, standard specifications and the manufacturer's recommendations, and shall result in a fully functioning system.

902.12.6.1 Splice Cabinet. The splice cabinet will be required only when shown on the plans. The splice cabinet shall be installed adjacent to controller cabinets and shall be a Type 336 cabinet with an Electronic Industries Alliance (EIA) 19-inch (480 mm) rack cage and a fiber distribution unit. Splice cabinets shall be installed on a separate concrete base as shown on the plans and in accordance with Sec 902.15.

902.12.6.2 Fiber Optic Closed Loop System Components. The principal components of the fiber optic closed loop system, including but not limited to, the local intersection controller(s), the on-street system master and the system software, shall be supplied by the contractor and shall be compatible with any existing systems.

902.12.6.2.1 System Master Controller. The system master controller shall consist of a fiber-ready NEMA or Type 170 controller as shown on the plans, prom module, Type 170 only, and all necessary connectors and cables. The system master shall include a fiber optic data link. The system master controller shall be installed in the local controller cabinet designated on the plans. A separate cabinet will not be required.

902.12.6.2.2 Local Controller Assembly. The local controller assembly shall consist of a fiber-ready NEMA or Type 170 actuated traffic controller assembly in accordance with Sec 1092 and the plans. The local controller shall include a fiber optic data link.

902.12.6.3. Fiber Optic Interconnect Cable.

902.12.6.3.1 The contractor shall provide trained and experienced personnel to supervise the installation of the fiber optic cable. Fiber optic cable shall be installed by trained personnel having a minimum of one-year current installation experience in fiber optic systems. The contractor shall provide a certification for each person installing fiber cable. The certification

shall show the amount of experience, the company or companies where experience was obtained and fiber optic training received. Methods of fiber optic installation, connections, splicing or other types of work with fiber optic cable shall be approved by the engineer before implementation by the contractor.

902.12.6.3.2 Installation of the fiber optic cable shall also be in accordance with the manufacturer's recommendations and practices. If the manufacturer's recommendations or practices appear to conflict with this specification, the matter shall be brought to the attention of the engineer for resolution.

902.12.6.3.3 Fiber optic interconnect cable shall be installed in continuous runs for each system, in conduit, pull boxes, splice cabinets or traffic signal controller cabinets. Splices outside of the splice cabinets or controller cabinets will not be permitted. Only those fiber tubes to be accessed in splice cabinets, controller cabinets and distribution units shall be opened, and only active fibers in that tube or tubes shall be cut and spliced. The manufacturer's recommended procedures for a mid-span access shall be followed. Continuous fiber tubes shall be neatly coiled, ensuring that the minimum bend radii are not violated, and shall be organized in the fiber distribution unit. The continuous fibers in the fiber tube(s) that have been opened shall be coiled in the appropriate splice tray. The fibers to be spliced shall be connected by fusion splicing methods with a maximum loss of 0.10 decibels, and the splice shall be held and secured in a fusion splice organizer on the trays. The dark fibers in the 6-fiber cable shall be secured to the splice organizer on the appropriate tray, but will not need to be spliced.

902.12.6.3.4 The contractor shall document the location and termination of all fibers in the appropriate cabinet. Written documentation shall be left in the cabinet and one copy shall be provided to the engineer.

902.12.6.3.5 Each end of the interconnect cable shall be sealed with a manufacturer approved end cap or pulling grip for use during installation. These caps or grips shall be removed only after complete installation of the cable and for the cable acceptance testing. End caps shall be installed to remain in place where fibers are not to be terminated.

902.12.6.3.6 The minimum bending radius and the maximum pulling force of the interconnect cable, as defined by the fiber optic cable manufacturer, shall not be exceeded during installation. Pulling of the cable shall be hand assisted at each pull box, splice cabinet and controller cabinet. The cable shall not be kinked, crushed or forced around a sharp corner. Pulling equipment may be used, however, all pulling equipment and hardware shall maintain the cable's minimum bend radius. Equipment that may contact the cable, such as sheaves, bending shoes, capstans and quadrant blocks, shall be designed for use with fiber optics. Where pulling equipment such as a winch is used, cable tension shall be continuously monitored. This may include use of a winch with a calibrated maximum tension or a dynamometer or in-line tensiometer.

902.12.6.3.7 If a lubricant is used, the lubricant shall be of the water based type as approved by the cable manufacture and shall be compatible with the pre-lubricated polyvinyl chloride conduit. Prior to use, the lubricant type and manufacturer’s name shall be supplied to the engineer for approval.

902.12.6.3.8 Sufficient slack shall be left at each splice cabinet and controller cabinet to allow proper termination. Each pull box adjacent to a signal cabinet or a splice cabinet shall contain a minimum of 60 feet (18 m) of coiled cable. Mid-block pull boxes shall contain a minimum of 10 feet (3 m) of coiled cable. Stored cable shall be neatly coiled as per the manufacturer's minimum bending radius specification. Where the size of the box precludes the coiling of cable above the minimum bending radius, the cable shall pass straight through the pull box.

902.12.6.3.9 The conduit containing only fiber optic interconnect cable shall be polyvinyl chloride or high density polyethylene conduit in accordance with Sec 1060 and shall be orange in color. A No. 14 AWG (2.5 mm^2) stranded copper tracer wire or a pull tape with a tracer wire shall be installed in the conduit.

902.12.6.3.10 At each pull box and controller cabinet, the interconnect cable shall be visibly marked "Caution - Fiber Optic Cable" by self-adhesive, weatherproof tags.

902.12.6.4 Testing. After the fiber optic cable installation, each fiber in each section shall be tested for attenuation and continuity, as a minimum. The contractor shall provide all personnel, equipment, instrumentation and supplies necessary to perform all testing. Any sections that fail the testing shall be replaced at the contractor's expense, and retested. All testing shall be performed in an accepted manner and in accordance with the testing equipment manufacturer's recommendations. All data shall be recorded and submitted to the engineer.

902.12.6.4.1 Attenuation. The end-to-end attenuation shall be measured for each link after installation by insertion loss testing.

902.12.6.4.1.1 The launch cable shall be connected to the light source and the receive cable to the power meter. The two reference cables shall then be connected via a termination hub. A reference power reading (P1) shall then be taken and recorded.

902.12.6.4.1.2 The system link to be tested shall then be inserted between the launch and receive cables using two termination hubs. A test power reading (P2) shall then be taken and recorded.

902.12.6.4.1.3 The link attenuation (A) in decibels shall be recorded as the mathematical difference between the reference power (P1) and the test power (P2).

902.12.6.4.1.4 Insertion loss testing shall be performed in both directions along the link. The direction of the test shall be recorded in the documentation.

902.12.6.4.2 Transmitter/Receiver Power Levels. The output power levels at the network hardware transmitters and receivers shall be measured and recorded for system documentation. The power meter shall be connected to the transmitter side of the equipment with a system jumper. The transmit power level shall then be read and recorded. The transmitter shall then be re-connected to the cable link and the power meter connected to the receiver side of the equipment. The receiver power level shall then be read and recorded.

902.12.6.4.3 Continuity. Continuity tests shall be used to determine whether a test or system jumper does or does not pass light. A continuity test shall also be used to assure the fibers have not been crossed over in the jumper and to assure that the transmit fiber goes to the receiver fiber. To perform the continuity test, a high-intensity flashlight shall be aimed into the connector at one end, while an observer watches for a flicker of light at the other end.

902.12.6.4.4 Optical Time Domain Reflectometer. An Optical Time Domain Reflectometer (OTDR) shall be used to evaluate the quality and length of cable reels prior to use. The fiber loss in decibels/km and the length of each reel shall be recorded in the documentation. The maximum attenuation of the cable shall be 3.5 decibels/km nominal, measured at room temperature at 850 nanometers, equivalent for single mode. A hard copy of OTDR signature traces for all system links shall be made and provided in the documentation.

902.12.7 System Acceptance Test. In addition to the standard testing requirements, the contractor shall successfully complete and document a four-part system acceptance test, in the presence of the engineer, unless approved otherwise, as follows:

(a) System Master Acceptance Test

(b) Office Computer Acceptance Test

(c) Notebook Computer Acceptance Test

(d) System Operational Test

902.12.7.1 System Master Acceptance Test. The system master acceptance test shall be conducted after all traffic signal improvements and the initial eight-hour training session has been completed. The test shall include the following:

(a) The contractor shall simulate a fault at a local controller and verify that the fault is recorded in the permanent log in the master and that the master automatically dials the office computer and transmits the same information.

(b) The contractor shall verify that scheduled timing plans change based on time of day.

(c) The contractor shall change one offset at a local controller and verify the change has been made and implemented at the local controller.

(d) The contractor shall verify a traffic responsive plan change is made at the appropriate time. This shall be demonstrated with simulated detector data.

(e) The contractor shall verify all programming data for the master and all locals can be downloaded/uploaded via the front panel RS-232 connection on the system master.

902.12.7.2 Office Computer Acceptance Test. The office computer acceptance test shall be conducted after successful completion of the system master acceptance test and shall include the following:

(a) A simulated fault at a local controller shall be recorded in the office computer log. The contractor shall verify the entry by printing a log report.

(b) The contractor shall reschedule a timing plan change and verify that the event happens at the new time.

(c) The contractor shall make a timing plan change and verify the change has been made at the local controller.

(d) The contractor shall print a report that shows all plan changes for the previous 24 hours.

(e) The contractor shall print a report showing volume and occupancy values from all system detectors for the previous 24 hours.

(f) The contractor shall call up a real-time intersection display.

902.12.7.3 Notebook Computer Acceptance Test. The notebook computer acceptance test shall consist of the same tests performed for the office computer acceptance test, except all

reports shall be displayed on the screen. This test shall be conducted only after the office computer acceptance test has been successfully completed. In addition, a complete local controller database shall be uploaded and downloaded from one controller to another using only the notebook computer, the cable provided and the two controllers.

902.12.7.4 System Operational Test. The system operational test shall be conducted after the system master, office computer and notebook computer acceptance tests have been successfully completed. The system operational test shall consist of a 30-day operational period, during which system failures are recorded. Any failure or malfunction of equipment during the test period shall be corrected at the contractor's expense, and the signal or system shall be tested for an additional 30 consecutive day period. This procedure shall be repeated until the signal equipment has operated to the engineer's satisfaction for 30 consecutive days. System failures will be defined, as a minimum:

(a) Local intersection controller failing to respond to the system master.

(b) System master failing to respond to either the office or notebook computer.

(c) A system detector failure.

902.12.8 Thirty-Day System Operational Test. The 30-day test shall replace the 15-day test period outlined in Sec 902.21. Liquidated damages will only be accumulated between the end of working days and the start of the final 30 consecutive day test period.

902.12.9 Documentation. Complete system documentation shall be provided. Documentation, as a minimum, shall include the results of all testing and shall be recorded along with date of test, name of person performing the test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data.

902.13 Detectors.

902.13.1 Induction Detector Probes. Detector probes installed under bridge decks shall be protected by completely encapsulating the probe in a conduit system. Probes shall be oriented such that the detection zone is above the bridge deck, and shall be installed in gasketed junction boxes anchored to the bottom of the deck. The junction boxes shall have a minimum size of 6 x 6 x 4 inches (150 x 150 x 100 mm) and the probes shall be rigidly anchored in the box. The probes shall be no more than 18 inches (450 mm) below the top of the bridge deck. Conduit shall be sized such that the probe and cable can be pulled through the conduit. Any conduit bends shall be such that the probe and cable can be pulled through the bend. External conduit on the structure shall be in accordance with Sec 902.16.

902.13.2 Induction Loop Detectors. A slot for the installation of induction loop cable shall be sawed in the pavement as shown on the plans. Slots shall not be sawed until seven days after placement of Portland cement concrete. Each loop shall have a separate lead-in slot to the conduit. A separate conduit shall be installed between the sawed loop slot and the first pull box for each loop. The conduit opening at the end of the lead-in slot shall be at the bottom of the sawed slot. The slot shall be clean. The cable shall be pushed into the slot without damaging the insulation. After the loop cable is spliced to the lead-in cable, and before the slot is sealed, the resistance of the loop and lead-in cable to ground shall be checked. The resistance test shall be performed by the contractor in the presence of the engineer and documented. After a satisfactory test, showing a resistance no less than 10 megaohms, the slot shall be sealed. The conduit opening at the end of the lead-in slot and any drilled conduit holes in the pavement shall be sealed with a pliable duct sealant prior to the application of loop sealant. All sawed slots shall then be sealed with an approved detector

loop sealant. All detector cable between the loop and detector amplifier shall be twisted at least three turns per foot (10 turns per m).

902.13.3 Microwave and Ultrasonic Detectors. Microwave and ultrasonic detectors shall be mounted at the locations shown on the plans in accordance with manufacturer's recommendations. All wiring shall be continuous and unspliced from the detector unit to the controller. The contractor shall make any necessary adjustments for proper operation of the detector.

902.13.4 Video Detection Systems. This work shall consist of furnishing, installing and placing into operation a vehicle detection system that detects vehicles by processing video images and providing detection outputs to a traffic signal controller. The system shall include all equipment shown on the plans and described in these specifications, and shall include any incidental items necessary for the satisfactory operation and maintenance of the system. The video detection system shall be installed per the manufacturer's recommendations. All cable runs shall be continuous without splice from the cabinet to the camera. If requested by the engineer, a factory certified representative from the supplier shall be available for on-site assistance for a minimum of one day during installation.

902.13.4.1 Camera. The bottom of the video camera shall be mounted a minimum of 30 feet (9 m) above the pavement.

902.13.4.2 Extra Service Outlet. A separate grounded service outlet shall be provided in the controller cabinet for supplying power to the video detection system. Use of the grounded service outlet located on the cabinet door will not be permitted.

902.13.4.3 Monitor. The monitor shall be installed to automatically power on when the cabinet door is opened and automatically power off when the cabinet door is closed. A manual on/off switch shall also be provided.

902.13.5 Detector Loop Sealant. Loop sealant shall be proportioned, mixed and installed per the manufacturer's specifications and recommendations. After the loop slots are cut into the pavement, the surface shall be thoroughly cleaned, and all loose debris shall be removed. After application of the sealant, the roadway shall be tack-free and capable of being open to the motoring public within four hours without tracking. Loop sealant shall fully encapsulate the loop wires as shown on the plans. Backer rods shall be placed to ensure a one-inch (25 mm) depth coverage of loops. Excessive overfill will not be permitted.

902.14 Pull and Junction Boxes. Pull and junction boxes shall be installed at locations as shown on the plans. Pull boxes placed in traveled ways, auxiliary lanes, shoulders and low profile islands shall be concrete.

902.14.1 Conduit shall enter the pull box in the side of the box and shall extend a minimum of 2 inches (50 mm) and a maximum of 4 inches (100 mm) as shown on the plans. If it becomes necessary to increase the excavation depth and extend the pull box, no direct payment will be made. The excavated opening outside the pull box shall be wide enough to allow compaction of the backfill material. Cinders, broken concrete, broken rock or other hard or undesirable material shall not be used for backfilling. The backfill material shall be placed in layers not to exceed 6 inches (150 mm) deep, and each layer shall be thoroughly compacted before the next layer is placed. Where preformed pull boxes are used, the holes for the conduit shall be drilled as recommended by the manufacturer. The holes shall be round and no more than 1/2 inch (13 mm) larger than the conduit.

902.14.2 Drains for pull boxes shall be constructed as shown on the plans.

902.14.3 The top surface of all pull boxes shall be flush with surfaced areas and approximately one inch (25 mm) above earth or sodded areas.

902.14.4 If preformed pull boxes are specified, the contractor may use standard concrete pull boxes in lieu of the Class 1 or 2 preformed pull boxes, or the Type A double concrete pull box in lieu of the Class 3 preformed pull boxes. For installations requiring different voltages for lighting and signal applications, the Type B double concrete pull box may be used in lieu of two preformed pull boxes at the contractor's expense. If the Type B double concrete pull box is specified, no substitutions will be permitted.

902.14.5 Class 5 preformed pull boxes shall be in accordance with all requirements in the contract documents. Installation of Class 5 pull boxes shall be as shown on the plans and in accordance with the manufacturer's recommendations.

902.15 Concrete Bases. Excavation for bases shall be made in a neat and workmanlike manner. While concrete is being placed, forms shall be level and sufficiently rigid to prevent warping or deflection. Concrete shall be Class B or concrete of a commercial mixture in accordance with Sec 501. Conduit, ground rods and anchor bolts shall be held rigidly in place before and during concrete placement. Tops of all bases shall be finished level and the perimeter edged to a radius of 1/2 inch (13 mm). Exposed surfaces of bases shall be finished in a workmanlike manner as soon as practical after removing forms. Concrete shall be placed, finished and cured in accordance with Sec 703.

902.15.1 Post Bases. Concrete bases for posts shall be in accordance with the dimensions shown on the plans. Metal forms no less than 26 inches (660 mm) high shall be used for all Type A bases. The top 12 inches (300 mm) of Type F bases shall be formed. Reinforcing steel for concrete bases shall be in accordance with Sec 706. Anchor bolts for steel posts and mast arms shall be as shown on the fabricator’s approved shop drawings. Conduit shall extend above all post bases a nominal 4 inches (100 mm).

902.15.2 Controller Bases. Concrete bases for controllers shall be constructed as shown on the plans. Aprons will be considered part of the controller base. A minimum of four anchor bolts shall be used for single controller cabinets and a minimum of six anchor bolts shall be used for double controller cabinets. The size of anchor bolts for controller cabinets shall be as specified by the cabinet manufacturer. A ground rod shall be placed into the ground with a minimum of 8 feet (2.4 m) of earth contact as shown on the plans. Bases for double controller cabinets shall have two ground rods, one positioned in each compartment. Conduit shall extend above all controller bases no more than one inch (25 mm). Bases for double controller cabinets shall have two conduits to the first pull box, one positioned in each compartment. All conduit openings in the controller cabinet or controller cabinet base shall be sealed with a pliable duct sealant in accordance with Sec 901.15 after wiring is completed.

902.16 Conduit Systems. The contractor may furnish and install rigid steel, intermediate metal, polyvinyl chloride (PVC) schedule 40 or high-density polyethylene (HDPE) conduit. Conduit shall be placed a minimum of 18 inches (450 mm) below finished grade and shall slope to a pull box at a minimum rate of 0.5 percent unless otherwise shown on the plans. A change in direction of conduit shall be accomplished by bending the conduit uniformly to a radius that will fit the location, or by the use of standard bends or elbows. The minimum radius of the bend shall be six times the internal diameter of the conduit. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. If it becomes necessary to cut and thread steel conduit, exposed threads will not be permitted. All conduit and fittings shall be free from burrs and irregularities. All conduits shall be cleaned and swabbed before cables are installed. All fittings shall be tightly connected to the conduit. Open ends of conduit placed for future use shall be capped or plugged. If approved by the engineer, conduit may be installed either by trenching or pushing; however, payment will be

made by the method specified in the contract for that conduit. Functionally equivalent English measure items may be substituted by the contractor for metric items specified or shown on the plans in accordance with Sec 901.15 upon approval from the engineer.

902.16.1 Metal Conduit. All metal conduit ends shall be provided with a bushing to protect the cable from abrasion. All metal conduits shall be electrically bonded by conduit clamps and bare No. 6 AWG (16 mm^2) stranded copper wire. All metal conduits in the controller base shall be electrically bonded to the power company ground.

902.16.2 Polyvinyl Chloride Conduit. A bare No. 6 AWG (16 mm^2) stranded copper ground wire shall be installed in each conduit and attached to the ground lug in signal posts, except as otherwise specified in this section. All bare ground wires shall be electrically bonded. All bare ground wires in the controller base shall be electrically bonded to the power company ground. PVC containing only fiber optic cable shall contain a bare or green-jacketed No. 14 AWG (2.5 mm^2) stranded copper tracer wire instead of a bare No. 6 AWG (16 mm^2) copper ground wire. Tracer wire shall not be pulled into the controller cabinet or bases. An additional 6 feet (2 m) of tracer wire shall be coiled in each pull box through which the fiber optic cable passes. Tracer wire in pull boxes shall be capped, not electrically bonded to any ground wires labeled "TRACER" and tagged in accordance with Sec 902.19. Ground wire and tracer wire shall be at the contractor's expense.

902.16.3 Conduit in Trench. Trenches shall be excavated to the width and depth necessary for conduit installation. All trenches shall be backfilled as soon as practical after the installation of conduit. Cinders, broken concrete and other hard or objectionable material that might cause mechanical damage to the conduit shall not be used for backfilling within 6 inches (150 mm) of the top of the conduit. The bottom of the trench shall be free of such material before the conduit is placed. Conduit shall not be placed without approval of the trench from the engineer. Backfill material shall be deposited in the trench in layers not exceeding 6 inches (150 mm) deep and each layer shall be compacted to the approximate density of the adjacent material by an approved method before the next layer is placed. Red burial tape imprinted with "CAUTION - BURIED CABLE BELOW" shall be installed in all trenches at approximately one-third to one-half of the depth of the trench. All disturbed areas shall be restored to the satisfaction of the engineer.

902.16.4 Pushed Conduit. If pushed conduit is specified, the conduit shall be installed without disturbing the existing surface. Pushed conduit may be placed by jacking, pushing, boring or other approved means.

902.16.5 Conduit in Median. If conduit in median is specified, the conduit shall be placed on the existing pavement prior to construction of the raised median. If conduit is to be placed in concrete traffic barrier, the conduit shall be held rigidly in place before placement of concrete.

902.16.6 External Conduit on Structure. For existing structures, or if provisions are not made in the plans for providing a conduit raceway in new structures as described in Sec 707, the conduit shall be external conduit on structure. Conduit on structure will include conduit on bridges, retaining walls or other structures, and shall be installed as shown on the plans or as directed by the engineer. The final location of all conduit and junction boxes shall be approved by the engineer before installation begins. Conduit shall not be attached to prestressed concrete girders or prestressed, precast concrete deck panels. The conduit shall be secured to the concrete with clamps at no more than 5-foot (1.5 m) intervals. Concrete anchors shall be in accordance with federal specification FF-S-325, Group II, Type 4, Class I, and shall be galvanized in accordance with ASTM A 153, B 695-91 Class 50, or constructed of stainless steel. The minimum embedment in concrete shall be 1 3/4 inches (44 mm). The supplier shall furnish a manufacturer's certification that the concrete anchors meet the required

material and galvanizing specifications. If necessary to anchor the conduit to steel bridge members, the attachment method shall not involve drilling, grinding or welding. Attachment method to steel members shall be approved by the engineer. Junction boxes shall be installed as shown on the plans or as directed by the engineer. Junction boxes shall be surface-mounted and installed such that covers are accessible. If the conduit crosses a bridge expansion joint, a conduit expansion fitting shall be used. The expansion fitting shall provide a minimum movement in either direction as shown on the plans or as specified by the engineer. Junction boxes, expansion fittings and any hardware or material required for conduit installation shall be at the contractor's expense.

902.17 Signal Faces. Vehicle and pedestrian signal faces shall be covered or turned away from approaching traffic until placed in operation. When ready for operation, the signal faces shall be securely fastened in position facing approaching traffic. Incandescent lamps installed by the contractor shall be installed horizontally with the open segment of the filament facing up. Vehicle and pedestrian signal faces shall be aimed laterally at the approximate center of the lane or lanes the signal face controls. Signal faces shall be aimed at a point behind the stop line a distance corresponding to the following requirements:

Approach Speed, mph (km/h)	Distance, feet (m)
30 (50)	160 (50)
40 (70)	240 (75)
50 (80)	330 (100)
60 (100)	430 (130)
70 (120)	560 (170)

902.18 Post Erection. Post bases shall be securely anchored to concrete bases. Pedestal posts shall be erected vertically without the use of leveling nuts. Metal posts for span wire and cantilever mast arms shall be adjusted by leveling nuts. All posts for span wire and cantilever mast arms shall be raked as directed by the engineer. All signal posts shall be grounded by a bare No. 6 AWG (16 mm^2) stranded copper wire running from the ground lug inside the post to a clamp fastened on metal conduit at the top of the concrete base to a ground rod or through nonmetallic conduit to the ground bus in the controller.

902.19 Wiring.

902.19.1 All cable runs shall be continuous and unspliced from the connections in the terminal block of the signal head or disconnect hanger to the terminal strip in the controller cabinet, from the signal terminal block to another signal terminal block or as shown on the plans. When a terminal compartment is provided, all cable runs shall be continuous from the terminal compartment to the terminal strip in the controller cabinet. When parallel connections are required from an overhead signal head on a mast arm to a side-mounted signal head, cable shall be routed from the controller to the terminal compartment of the signal on the mast arm and then parallel-circuited back to the side mounted signal. All other conductor cable combinations to signal heads shall be as shown on the plans or as directed by the engineer. Where double controller cabinets are specified, wires shall be sorted between the controller and first pull box such that field wires enter the associated controller compartment.

902.19.2 Power cable runs shall be continuous and unspliced from the power disconnect switch located on the power supply to controller cabinet terminals. Power cable shall be encased in conduit of the size shown on the plans. Energized power cables shall run to circuit breakers. The neutral cable shall be terminated on the neutral bus bar and the equipment ground conductor shall be terminated on the ground bus in the controller cabinet.

902.19.3 Where luminaires are required, pole and bracket cable shall be installed between the luminaire and the power source at the base of the post. Each luminaire shall be connected to the power source by No. 12 AWG (4 mm^2) conductors with suitably sized equipment grounding conductor. A premolded fused connector assembly shall be installed on each conductor carrying current between the source cable and the pole and bracket cable. The assembly and cable shall be insulated with a protective rubber boot designed for the premolded connector.

902.19.4 Induction loop dimensions shall be as shown on the plans. The engineer will determine the exact location of loops. Each induction loop shall be connected to the detector by a separate lead-in cable. Single-conductor No. 14 AWG (2.5 mm^2) cable shown on the plans is an approximation of cable quantity required to construct the induction loop. If the number of turns shown on the plans is not in accordance with the manufacturer's recommendation for the sensing units furnished, the plans will be revised, the induction loop cable will be field measured and quantities adjusted accordingly. Induction loop detector cable shall be installed in accordance with manufacturer's recommendations. Induction loop detector lead-in cable will be shown on the plans as two-conductor No. 14 AWG (2.5 mm^2) cable. Should the manufacturer recommend a different type of cable, the two-conductor cable shall be revised to the manufacturer's specification, but will be considered completely covered by the contract unit price for loop detector lead-in cable. Cable for loop detectors shall be continuous from the terminal strip in the controller cabinet to a splice with the detector leads in the pull box adjacent to the detector. The conductor splice shall be soldered without an open flame. The soldered splice shall then be capped and inserted into a direct buried splice kit.

902.19.5 Where practical, color codes shall be followed such that the red insulated conductor connects to the red indication terminal, orange to yellow and green to green. Circuits shall be properly labeled in the controller cabinet and all pull boxes by means of round aluminum identification tags with a minimum thickness of 0.1 mils (2.5 µm), attached to the cables with a copper wire. Information stamped on the tags shall identify equipment served by the conductor cable in accordance with designations used on the plans.

902.19.6 Cables shall be pulled through conduit by a cable grip providing a firm hold on exterior coverings. Cable shall be pulled with a minimum of dragging on the ground or pavement. Frame-mounted pulleys or other suitable devices shall be used for pulling cables out of conduit into pull boxes. Lubricants may be used to facilitate pulling cable. Polyester rope will not be permitted to facilitate pulling of cable. Slack in each cable shall be provided by a 6-foot (2 m) loop coiled in each pull box and a 3-foot (1 m) loop coiled in each junction box. All signal posts and controllers shall be grounded by bare No. 6 AWG (16 mm^2) stranded copper wire.

902.19.7 Functionally equivalent English measure items may be substituted by the contractor for metric items specified or shown on the plans in accordance with Sec 901.15, upon approval from the engineer. The following table of functionally equivalent items may only be used for the substitution of English measure items for metric measure items where applicable. Value engineering will not be permitted for any of the below substitutions.

Conductor, Cable and Wire Sizes (Nominal)		
Type	**Specified (mm^2)**	**Equivalent (AWG)**
3-Pair Interconnect	1.5	16
Solid Neutral	16	6

902.20 Test Equipment. During installation of equipment and material, the contractor shall furnish to the engineer suitable equipment to test all or part of the completed facility to establish compliance with requirements of the contract. Minimum test equipment shall be a

voltmeter, ohmmeter and ammeter. For testing induction loop detectors, the contractor shall also provide a suitable 500-volt, direct current, 0 to 100- megaohm range, hand-operated, resistance measuring device.

902.21 Test Period. After the project is open to normal traffic, the contractor shall notify the engineer in writing the date the signal or signal system will be ready for testing. Upon concurrence from the engineer, the contractor shall place the signal or signal system in operation for a 15 consecutive day test period. A signal operated independently of other signals or signal systems shall be tested as a single installation. A signal operated as part of a system shall not be tested until all signals in the system are ready to be tested. A system shall be tested as a unit. Any failure or malfunction of equipment during the test period shall be corrected at the contractor's expense, and the signal or signal system tested for an additional 15 consecutive day period. This procedure shall be repeated until the signal equipment has operated to the engineer's satisfaction for 15 consecutive days. The contractor shall, in the presence of the engineer, demonstrate the proper action of the controller's monitor as part of the testing system, if applicable.

902.21.1 When the test period is initiated and until the test period is completed, following the turn on of temporary traffic signals or after work is begun on an existing signal installation, the contractor shall provide at least one service technician to remain in the area and be available for day, night and weekend trouble calls. The contractor shall furnish the name, address and telephone number where each designated technician can be reached at all times. In the event of a malfunction, the contractor shall provide adequate traffic control for the intersection until the signals are restored to normal operation. Adequate traffic control shall be as shown on the plans or as directed by the engineer. If the signal or signal system malfunctions and a designated technician cannot be reached or cannot arrive at the intersection in a reasonable time in the judgment of the engineer, then the engineer may exercise the option to direct MoDOT personnel or a third party to correct the malfunction in the presence of the engineer. If this option is invoked, the entire cost of the work performed by MoDOT personnel or the third party will be computed as described in Sec 108.9 and deducted from the payments due the contractor.

902.21.2 Whether or not the engineer elects to correct the signal malfunction, nothing in this specification shall be construed or interpreted to relieve the contractor of any liability for personal injury or property damage that results either directly or indirectly from a signal malfunction during the test period. The contractor and surety shall indemnify and save harmless the State, the Commission, the Commission’s agents, employees and assigns for any legal liability incurred for such a signal malfunction.

902.22 Maintenance Information. Before acceptance of the work, the contractor shall furnish the engineer with three copies of the manufacturer's instructions for maintenance and operation of all signal equipment including, but not limited to, controllers, conflict monitors, load switches, detectors, software, interconnect and auxiliary equipment. At a minimum, the manufacturer's instructions shall include organized written instructions, wiring diagrams, diagrams showing component layouts and parts lists with part numbers and serial numbers, where applicable. Serial numbers listed by the supplier will be verified with the shipping invoice and on the controller and conflict monitor received for installation. The contractor shall furnish three copies of wiring diagrams of the installation or system. The cabinet wiring diagrams shall include labeling for all field terminal connections and shall provide an orientation of the terminal layout that conforms to the intersection information specified.

902.23 Final Clean Up. .Final clean up of right of way shall be in accordance with Sec 104.

902.24 Method of Measurement.

902.24.1 Measurement of temporary traffic signal installations will be made per lump sum.

902.24.2 Measurement for the following items will be made per each:

(a) Signal heads and luminaires.

(b) Posts.

(c) Power supply assemblies, including all specified equipment.

(d) Traffic controller assemblies, including all specified equipment.

(e) System software, including installation.

(f) System master, including all specified items.

(g) Telemetry radios and antennas for wireless interconnect systems, including all specified equipment.

(h) Video detection systems, including all specified equipment.

(i) Pull boxes, including all specified material.

(j) Training, including all specified training.

(k) Modems, including all specified equipment.

(l) Splice cabinet, including all specified items.

All necessary material, hardware, equipment and specified incidental items.

902.24.3 Measurement of push button detectors, microwave detectors and induction probe detectors will be made per each. Measurement of two-channel card rack mounted detectors will be made per each detector card.

902.24.4 Final measurement of concrete for bases will not be made, except for authorized changes in construction or where appreciable errors are found in the contract quantity. Where required, measurement of concrete for bases, including all specified material, will be made to the nearest 1/10 cubic yard (0.1 m^3) as shown on the plans. The revision or correction will be computed, and added to or deducted from the contract quantity.

902.24.5 Final measurement of conduit will not be made, except for authorized changes in construction or where appreciable errors are found in the contract quantity. Where required, measurement of conduit will be made to the nearest linear foot (0.5 m) as shown on the plans. The revision or correction will be computed, and added to or deducted from the contract quantity.

902.24.6 Final measurement of conductor will not be made, except for authorized changes in construction or where appreciable errors are found in the contract quantity. Where required, measurement of conductor will be made to the nearest 10 linear feet (5 m) as shown on the plans. The revision or correction will be computed, and added to or deducted from the contract quantity.

902.25 Basis of Payment. Accepted traffic signals will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for any

incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

902.25.1 Temporary traffic signals will be paid for at the contract unit price. No direct payment will be made for guys, conduit and junction boxes on poles, hardware, lighting bracket arms, or any other item for which separate payment is not provided.

902.25.2 Accepted post bases will be paid for at the contract unit price. Payment will be considered full compensation for all labor, equipment and material to complete the described work, and will include all excavation, removal and disposal of all material encountered within the limits of the work.

902.25.3 Luminaire bracket arms, if specified, will be at the contractor's expense.

902.25.4 No direct payment will be made for cable, conduit and any additional work required to connect the power supply assembly to the utility company facilities.

902.25.5 No direct payment will be made for the card rack assembly and card rack power supplies.

902.25.6 Payment for the telephone cable and associated pushed or trenched conduit will be considered fully covered under the contract unit price for the power supply assembly.

902.25.7 Furnishing and installing the system master controller, including all connectors and cables to provide a fully functioning system, will be paid for at the contract unit price per each. Payment for furnishing and installing telephone interface panels, an extra service outlet, door alarm, dial-up modem and all aspects of the system acceptance test, including all incidental items required to provide a fully functioning system, will be considered completely covered by the contract unit price for the system master.

902.25.8 For closed loop systems, if the Commission does not furnish the system software, the system software will be paid for at the contract unit price per each. If the Commission furnishes system software or has committed to purchase system software in another contract, no payment will be made for the software. This shall include versions of previously supplied software. Installing and programming local intersection controllers and the system master will be at the contractor's expense.

902.25.9 Accepted video detection systems will be paid for at the contract unit price. Payment will be considered full compensation for all labor, equipment and material to complete the described work, and for placing the specified equipment into operation to the satisfaction of the engineer.

902.25.10 No direct payment will be made for junction boxes.

902.25.11 Furnishing and installing telemetry radios, power supplies, interface cables, diagnostic pads and other items necessary for the proper operation of the radios will be paid for at the contract unit price for the Spread Spectrum Telemetry Radio.

902.25.12 Furnishing and installing antenna cable, including connectors, surge arrestors and other items necessary for proper operation, will be paid for at the contract unit price of RG-8/U Coaxial Cable.

902.25.13 If training is specified in the contract documents, training will be paid for at the contract unit price. Payment will be considered full compensation for all labor, equipment and material to conduct the training.

902.25.14 The accepted quantities of fiber optic cable, including installation, termination and testing of the fiber optic interconnect cables, all connectors, hardware, tags and other incidentals needed to provide a fully functioning system, will be paid for at the contract unit price per linear foot (m). The installation, termination and splicing of fibers in splice cabinets and fiber distribution units, including all connectors and other incidentals, will be considered fully covered under the contract unit price.

902.25.15 The fiber optic data link in the system master, including all incidental items required for proper operation, will be paid for at the contract unit price per each for the system master.

902.25.16 Furnishing and installing the dial-up modem including all connectors and cables necessary for proper operation will be paid for at the contract unit price per each.

902.25.17 Furnishing and installing the local controller assembly, including all connectors and cables to provide a fully functioning system, will be paid for at the contract unit price per each.

902.25.18 Furnishing and installing the fiber optic data links (modems) in the local controllers including all incidental items required to provide a fully functioning system, will be paid for at the contract unit price per each for controller assembly.

902.25.19 Furnishing and installing the fiber distribution unit for controller cabinets, including all mounting hardware and incidentals, will be paid for at the contract unit price per each for controller assembly.

902.25.20 Furnishing and installing the splice cabinet, including the rack cage, fiber distribution unit, grounding and other incidental items will be paid for at the contract unit price per each.

902.25.21 Payment for the telephone cable and associated pushed or trenched conduit will be considered fully covered under the contract unit price for the power supply assembly.

902.25.22 No direct payment will be made for warranties.