

**SPECIAL PROVISIONS
TRAFFIC SIGNAL INSTALLATION**

S.C FILE NO:**PROJECT NO:****COUNTY****(1) PROJECT DESCRIPTION -**

1.1 Scope. This Project involves the _____ of ___ intersections along _____ in and around the city of _____, South Carolina. The intersections involved are shown on the attached "List of Project Signals". The Department will furnish the signal controller cabinets, and detector amplifiers. Otherwise, this is a "turn-key" project, with the contractor furnishing and installing all other equipment, complete and operational to the satisfaction of the Engineer.

1.2

**** The Traffic control specification and requirements have changed and the revisions are in these Project Specifications. ****

Documentation - The CONTRACTOR shall submit for approval a list of equipment including make, model number, manufacturer serial numbers, and warranty information. If equipment is on the SCDOT Equipment Contract or the SCDOT QPL, catalog cut sheets do not have to be provided. On all other equipment, the CONTRACTOR shall submit for approval, catalog descriptions and documentation--THREE (3) COPIES--for each class of signal equipment and materials furnished by the CONTRACTOR. They are to be submitted PRIOR TO INSTALLATION to the Construction Office FOR APPROVAL. The following is a list of potential furnished signal equipment. Documentation only has to be submitted for the furnish items required for this contract.

1. Electrical Cable
2. Communication Cable
3. Fiber Optic Cable
4. Fiber Interconnect Center / Fiber Splice Trays
5. Loop Wire and Sealant
6. Splice Boxes / Junction Boxes
7. Steel Cable
8. Vehicle Signal Head with LED Modules
9. LED Blank Out Signs
10. Optically Programmable Vehicle Signal Head
11. Pedestrian Signal Head
12. Pedestrian Push Button Station Assembly
13. Steel Strain Pole
14. Mast Arm
15. Concrete Strain Pole
16. Controllers and 332/336 Cabinets
17. Spread Spectrum Radio Assembly
18. Ethernet Extender

(2) GENERAL PROVISIONS -

2.1 All work under this Contract shall be performed under: the SOUTH CAROLINA DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION, "STANDARD SPECIFICATIONS FOR HIGHWAYS CONSTRUCTION", Latest Edition; these SPECIAL PROVISIONS; the "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS" (latest revision); and the PLANS.

2.2 Section numbers appearing in these SPECIAL PROVISIONS refer to the section numbers in the STANDARD SPECIFICATIONS referenced above.

(3) CODES, LICENSES, & ABILITIES -

3.1 All work shall be done in a workmanlike manner to meet the highest industry standards, all in accordance with the requirements of the latest editions of the National Electrical Code (NEC), National Electrical Safety Code (NESC), the Illuminating Engineering Society (IES), American National Standards Institute (ANSI), National Electrical Manufacturer's Association (NEMA), and the regulations and standards of the local power company.

3.2 The following supplements Section 102.1. The contracting firm responsible for the performance of the work covered by these SPECIAL PROVISIONS, **must be licensed by the SC Licensing Board For Contractors, and possess a Journeyman Card issued by the South Carolina Municipal Association or as required by the city in which work occurs.**

Further, at least one '**ON-SITE**' field supervisor shall have **LEVEL II** or higher, Traffic Signal Certification by the International Municipal Signal Association (IMSA). Photo copies of the license and certificate (for both above) shall be submitted at the PRE-CONSTRUCTION CONFERENCE, and must be approved by the Engineer before work is allowed to commence. The CONTRACTOR shall retain employee(s) holding the above certificate for the duration of the project; and the employee(s) shall be present **DAILY** and at the **FINAL INSPECTION**.

3.3 The CONTRACTOR shall employ persons capable of programming traffic signal controllers of the type used by this project. The CONTRACTOR shall possess both a desktop and a portable (laptop) computer, and be capable of using them to upload and download signal operating parameters.

(4) SYSTEM INTEGRATION -

4.1 **THIS IS A "TURN-KEY" PROJECT**", WITH THE CONTRACTOR PERFORMING **ALL**- ACTIVITIES, complete and to the satisfaction of the Engineer. The district will provide all timing parameters for the system.

(5) QUANTITY LISTS -

Quantity Lists for "EQUIPMENT TO BE FURNISHED AND INSTALLED BY THE CONTRACTOR" are available from Traffic Engineering at (803) 737-1050.

(6) SUPPLEMENTAL SPECIFICATIONS -

6.1 The signal(s) shall be constructed in accordance with the detailed "**SUPPLEMENTAL SPECIFICATIONS FOR TRAFFIC CONTROL SIGNALS**"; and the plan details "**TRAFFIC SIGNAL STANDARDS**"; which by reference are made a part of these SPECIAL PROVISIONS. These documents may be obtained from the SCDOT, Director of Traffic Engineering, Traffic Signal & Systems Engineer, PO BOX 191, Columbia, SC 29202-0191.

(7) SPECIAL INSTRUCTIONS TO CONTRACTOR -

7.1 This is a "TURN-KEY" project. The PLANS are schematic in nature, showing what is generally expected at each intersection. The CONTRACTOR must devise/refine the final details, working within the Supplemental Specifications, the Design Details, the Standards, and with the Engineer. Any deviation from the Plans must be approved by the Engineer.

7.2 At Project completion all traffic signals/equipment shall be complete and operational, to the satisfaction of the Engineer.

7.3 The CONTRACTOR shall furnish and install conduit, and splice (pull) boxes in the project, as shown on the Plans.

7.4 The equipment to be furnished by the Department includes controllers, cabinets and detector amplifiers.

NOTE: Contractor to install Department Furnished Equipment as directed by the appropriate 'Furnish and Install Specification'.

7.5 The CONTRACTOR SHALL FURNISH ALL OTHER MATERIALS such as signal heads, electrical wire and cable, span wires, signal lamps, sign brackets, loop detector sealant, conduit, miscellaneous fittings, electrical service parts, clamps, signs, ground rods, span wire fittings, staples, tape, and all other materials.

7.6 The Department shall furnish and the CONTRACTOR SHALL INSTALL ___ cabinets and ___ loop detector amplifiers.

The CONTRACTOR shall program each controller, to develop the phasing shown on the Plans, or the Phase Chart, or the Signal Sequence Diagram.

7.7 The CONTRACTOR will install the traffic signal to provide a completely modern installation. The CONTRACTOR shall install a new METERED ELECTRICAL SERVICE where shown on the plans. NOTE: the service may be either: Underground, -or- Overhead; depending on the latest requirements of the Power Company. Bids should be prepared accordingly. The CONTRACTOR shall furnish and install ALL NEW STEEL CABLE as directed on the plans and ALL NEW ELECTRICAL CABLE.

7.8 The CONTRACTOR shall furnish and install TRAFFIC SIGNAL HEADS, ELECTRICAL CABLE, AND CONDUIT as shown on the Plans. The CONTRACTOR shall install detector loops in the size, shape, and location shown on the Plans.

7.9 In addition to the state requirements, all permits and licenses required by a City/County are the responsibility of the CONTRACTOR. The CONTRACTOR shall arrange with the utility company for hookup connections and attachment agreements.

7.10 The CONTRACTOR shall adjust the existing down guy or aerial guy attachments to match with the new span attachment.

(8) INSPECTION -

8.1 RCE. During construction, the INSPECTION will be the responsibility of the Department. The Department's Resident Construction Engineer (RCE), is the designated representative of the Engineer, for the purposes of this project.

8.2 Disputes. The CONTRACTOR is advised that in any dispute between the Contractor and the Manufacturer, concerning the operation/maintainability/reparability of any piece of equipment, THE DECISION OF THE ENGINEER SHALL BE FINAL.

8.3 Faulty Equipment. When equipment supplied by the Department is designated faulty by the RCE, if it is under warranty, the Contractor shall return it to the Manufacturer for replacement. The Manufacturer shall furnish a replacement unit.

(9) MAINTENANCE OF TRAFFIC -

The CONTRACTOR shall maintain traffic throughout the length of this Project as required by the Standard Specifications. Additional traffic control shall be provided during traffic signal construction or lane closures, as directed by the Engineer.

(10) CONTRACT SCHEDULE -
For the TRAFFIC SIGNAL CONSTRUCTION work, each Friday, for the week to come, the CONTRACTOR shall furnish the Resident Construction Engineer with a WEEKLY SCHEDULE, listing the location and date of each intended activity. This will permit scheduling signal inspection personnel. Deviation from this schedule may cause the Department to delay Inspection and Payments.

(11) PAYMENT FOR MATERIALS ON HAND -
 The attention of the CONTRACTOR is directed to Section 109.7 of the STANDARD SPECIFICATIONS; which is amended to include the following paragraphs.

When permitted by the Engineer, partial payment will be made for major traffic signal items that are being furnished by the CONTRACTOR. Certain items such as wooden poles, and other very heavy units not readily movable or vandalized, may be stored in un-secured locations either ON- or OFF-SITE. Other items such as signal heads, detector amplifiers, controllers, cabinets, and certain other major items may be stored in a secured/protected location either ON- or OFF-SITE. The equipment shall be labeled stating SCDOT, and the Project Name. Other requirements of Paragraph 109.8 remain applicable. Payment shall be in accordance with the following criteria:

1. For MATERIALS ON HAND, the Contractor may be paid at:
FIFTY (50%) PERCENT OF THE CONTRACT UNIT PRICE OF ITEM,
NOT TO EXCEED THE PAID INVOICE AMOUNT.
2. ONLY ITEMS MEASURED BY --EACH-- SHALL BE ELIGIBLE.
3. ONLY ITEMS WITH A UNIT PRICE EXCEEDING \$100
SHALL BE ELIGIBLE.
4. THE TOTAL INVOICE PRICE OF THE ITEMS SHALL EXCEED \$5000.

**LIST OF PROJECT INTERSECTIONS TO BE UPGRADED
TRAFFIC SIGNAL INSTALLATION**

Intersection No.	Intersection Name	Comment*

*See Plans for installation and upgrade details – The information listed here is meant as special comments and not a complete inventory of the systems upgrade

PROJECT SPECIFICATIONS**1. GENERAL -****1.1 Notifications -**

1.1.1 Prior to beginning construction, the CONTRACTOR shall participate in a "Pre-Construction Conference" at a time and place to be scheduled by the Department's Resident Construction Engineer (RCE).

1.1.2 Any work performed without notification of the proper parties in the Department, will be treated as unauthorized work (see Section 105.11 of the Standard Specifications), and could result in nonpayment to the CONTRACTOR for that work.

1.2 Testing -

1.2.1 Inspection. This Project involves equipment previously purchased under a State annual contract, *plus* some additional equipment furnished by the CONTRACTOR. ALL MATERIALS shall be Inspected, Tested, and/or Checked for Certification, and shall be accepted by the Engineer, before being incorporated into the work. The CONTRACTOR is to assemble for system simulation testing: On-street Masters, Controllers, Cabinets, Modems, and Detector Amplifiers, at a site designated by the Engineer. Depending on circumstances, the site may be

** SCDOT, District __ Electrical/Signal Shop **

1.2.2 Testing. Each Controller will be tested before installation on the street. The TEST will consist of complete system hookup, connection and operation of the Central Monitoring Computer, the On-street Masters, Modems, Internal Coordinators, and the Controllers, in a manner to simulate Closed Loop OPERATION. Cabinets shall be tested under electrical load. Tests will be performed by the CONTRACTOR, assisted and witnessed by the District Electrical Shop. It is the responsibility of the CONTRACTOR to arrange the TEST with the Shop, through the Engineer, and the Type 170 equipment manufacturers if needed. Proper operation of the System shall be demonstrated. The CONTRACTOR SHALL TEMPORARILY PROVIDE WIRE, CHEATER CORDS, INTERCONNECT CABLE, AND LAMP LOAD BANKS to conduct these simulation / validation tests.

1.2.3 Duration. During the TEST, the equipment must perform satisfactorily for a PERIOD OF SEVEN (7) DAYS for interconnected signals and THREE (3) DAYS for stand alone signals. If, during this time, any problem develops, it MUST BE RESOLVED, and a NEW seven/three day test period begun. At the conclusion of the test, the CONTRACTOR shall pick up the control equipment from the Shop. The delivery, testing, and pickup of the control equipment, is incidental to the equipment being furnished. NO separate payment shall be provided.

1.2.4 Compatibility. To insure compatibility, any additional equipment required during the life of this contract, as Change Order or Extra Work, shall be purchased by the CONTRACTOR from the same Manufacturer as the original item. These too shall be tested as above.

1.3 Documentation -

1.3.1 The CONTRACTOR shall submit for approval a list of equipment including make, model number, manufacturer serial numbers, warranty information and receipts for purchase of equipment. If equipment is on the SCDOT Equipment Contract or the SCDOT QPL, catalog cut sheets do not have to be provided. On all other equipment, the CONTRACTOR shall submit for approval, catalog descriptions and documentation--THREE (3) COPIES--for each class of signal equipment and materials furnished by the CONTRACTOR. They are to be submitted prior to installation to the Construction Office FOR APPROVA.

1.3.2 At the time of such submission, the CONTRACTOR shall provide a copy of the Transmittal Letter, to the Engineer.

1.4 Power -

The CONTRACTOR, prior to beginning of any construction activity, shall coordinate as necessary with the Utility Company supplying the power for this project. A representative of the Utility Company should be present at the RCE's Pre-Construction Conference.

2. SUBMITTING AS-BUILT PLANS -

2.1 After the completion of the project, the CONTRACTOR shall furnish to the Engineer, three (3) "red-lined" sets of Plans showing the exact locations and sizes of all conduits, poles, pedestals, splice boxes, detectors, and the routing and destination of all wires leaving the control cabinets.

3. FINAL INSPECTION -

3.1 Request - The CONTRACTOR shall request Final Inspection one week prior to the desired day of inspection. Confirmation to the Resident Construction Engineer shall be provided forty-eight (48) hours prior to Final Inspection, that the project is on schedule and ready for inspection.

3.2 System Test - Upon completion of the Final Inspection and correction of any deficiencies, the work will be subject to a **sixty (60) day operational test** for the System, and for individual intersections. If during this period a problem arises in either the System or an individual traffic signal, it must be resolved, and a **NEW sixty (60) day test** period shall begin.

4. TRAFFIC CONTROL:

The Contractor shall execute the item of Traffic Control as required by the Standard Specifications, the plans, the Standard Drawings For Road Construction, these special provisions, all supplemental specifications, the MUTCD, and the Engineer. This is an amendment to the Standard Specifications to require the following:

GENERAL REGULATIONS -

These special provisions shall have priority to the plans and comply with the requirements of the MUTCD and the standard specifications. Revisions to the traffic control plan through modifications of the special provisions and the plans shall require approval by the department. **Final approval of any revisions to the traffic control plan shall be pending upon review by the Director of Traffic Engineering.**

Install and utilize changeable message signs in all lane closures installed on high volume high-speed multilane roadways. Use of changeable message signs in lane closures installed on low volume low speed multilane roadways is optional unless otherwise directed by the plans and the Engineer. Install and use a changeable message sign within a lane closure set-up as directed by the *Standard Drawings For Road Construction*. When a lane closures is not present for any time to exceed 24 hours, remove the changeable message sign from the roadway. Place the sign in a predetermined area on the project site, as approved by the Engineer, where the sign is not visible to passing motorists. The preprogrammed messages utilized shall be in accordance with the *Standard Drawings For Road Construction* when used as part of the traffic control set-up for lane closures. Only those messages pertinent to the requirements of the traffic control situation and the traffic conditions are permitted for display on a changeable message sign at all times. At no time will the messages displayed on a changeable message sign duplicate the legends on the permanent construction signs.

During operation of changeable message signs, place the changeable message sign on the shoulder of the roadway no closer than 6 feet between the sign and the near edge of the adjacent travel lane. When the sign location is within 30' of the near edge of a travel lane open to traffic, supplement the sign location with no less than 5 portable plastic drums placed between the sign and the adjacent travel lane for delineation of the sign location. Install and maintain the drums no closer than 3 feet from the near edge of the adjacent travel lane. This requirement for delineation of the sign location shall apply during all times the sign location is within 30' of the near edge of a travel lane open to traffic, including times of operation and non-operation. Oversized cones are prohibited as a substitute for the portable plastic drums during this application.

All signs mounted on portable sign supports shall have a minimum mounting height of 5' from the ground to the bottom of the sign. All signs mounted on ground mounted u-channel posts shall have a minimum mounting height of 7' from the ground to the bottom of the sign.

Temporary "Exit" signs (M1025-00) shall be located within each temporary gore during lane closures on multilane roadways. Mount these signs a minimum of 7' from the pavement surface to the bottom of the sign in accordance with the requirements of the MUTCD.

When covering signs with opaque materials, the Department prohibits attaching a covering material to the face of the sign with tape or a similar product or any method that will leave a residue on the retroreflective sheeting. Residue from tape or similar products, as well as many methods utilized to remove such residue, damages the effective reflectivity of the sign. Therefore, contact of tape or a similar product with the retroreflective sheeting will require replacement of the sign. Cost for replacement of a sign damaged by improper covering methods will be considered incidental to providing and maintaining the sign; no additional payment will be made.

Overlays are prohibited on all rigid construction signs. The legends and borders on all rigid construction signs shall be either reversed screened or direct applied.

Signs not illustrated on the typical traffic control standard drawings designated for permanent construction signs shall be considered temporary and shall be included in the lump sum price bid item for "Traffic Control" unless otherwise specified.

The Contractor shall maintain the travel patterns as directed by the traffic control plans and shall execute construction schedules expeditiously. The Contractor shall provide the Resident Engineer with no less than a two-week prior notification of changes in traffic patterns.

During nighttime flagging operations, flaggers shall wear a safety vest and safety pants that comply with the requirements of ANSI / ISEA 107-2004 standard performance for Class 3 risk exposure or latest revisions and a fluorescent hard hat. The safety vest and the safety pants shall be retroreflectorized and the color of the background material of the safety vest and safety pants shall be fluorescent orange-red or fluorescent yellow-green.

During nighttime flagging operations, the contractor shall illuminate each flagger station with any combination of portable lights, standard electric lights, existing street lights, etc., that will provide a minimum illumination level of 108 Lx or 10 fc.

During nighttime flagging operations, supplement the array of advance warning signs with a changeable message sign for each approach. These changeable message signs are not required during daytime flagging operations. Install the changeable message signs 500' in advance of the advance warning sign arrays. Messages should be "Flagger Ahead" and "Prepare To Stop".

TRAFFIC CONTROL PROCEDURES –

Utilize a vehicle train consisting of a primary work vehicle and no less than 1 shadow vehicle. A second shadow vehicle is necessary when simultaneously operating in multiple travel lanes. Install and maintain the vehicle train as directed by these special provisions, the Standard Drawings For Road Construction, and the Engineer.

Two-Lane Two-Way Roadways

- A. Utilize flagging operations to control the traffic flow around the work site where the vehicle train is operating.
- B. Utilize flaggers to control the traffic flow on an intersecting two-lane two-way roadway. Only flaggers and advance warning signs are required on the approaches intersecting the travel lane the vehicle train is operating in. Traffic control devices are not required on the intersecting approaches. The advance warning signs for the flagging operations shall include the following:
 - W20-7a-48 Flagger symbol
 - W20-4-48-A One Lane Road Ahead
 - W20-1-48-A Road Work Ahead
- C. Maintain two-way radio communications between all flaggers.

Multilane Roadways

- A. During work operations that require the vehicle train to encroach upon or operate within the limits of a travel lane for a time duration of 15 minutes or less, advance warning signs may be omitted.
- B. During work operations that require the vehicle train to encroach upon or operate within the limits of a travel lane for a time duration in excess of 15 minutes but less than 60 minutes, advance warning signs are required. Typical advance warning signs required for a temporary closure of a travel lane shall include the following:
 - W4-2R(L)-48 Lane Ends symbol
 - W20-5R(L)-48-A Right (Left) Lane Closed Ahead
 - W20-1-48-A Road Work Ahead
- C. Utilization of flaggers to control the traffic flow in the travel lanes adjacent to the travel lane the vehicle train is operating in is PROHIBITED.
- D. Utilize flaggers to control the traffic flow on an intersecting two-lane two-way roadway. Only flaggers and advance warning signs are required on the approaches intersecting the travel lane the vehicle train is operating in. Traffic control devices are not required on the intersecting approaches. The advance warning signs for the flagging operations shall include the following:
 - W20-7a-48 Flagger symbol
 - W20-4-48-A One Lane Road Ahead
 - W20-1-48-A Road Work Ahead
- E. **During work operations that require the vehicle train to encroach upon or operate within the limits of a travel lane for a time duration in excess of 60 minutes, install a**

**standard lane closure as directed by these special provisions, the Standard Drawings
For Road Construction, and the Engineer.**

Conduct all equipment and material preparations prior to entering the roadway.

Avoid conducting traffic signal work or similar work activities that interfere with or create disruptions to normal traffic operations during morning, mid-day, and afternoon-evening high traffic volume peak periods when possible.

Conduct all work activities within the boundaries of a travel lane closed to vehicular traffic or a pedestrian thoroughfare closed to pedestrian traffic. Conducting work activities over a travel lane open to traffic is PROHIBITED. Conducting work activities over a pedestrian thoroughfare open to pedestrian traffic is PROHIBITED. Do not conduct any work activities in any manner over a thoroughfare open to vehicular or pedestrian traffic.

When advance warning signs are required to supplement the vehicle train, install the advance warning signs at spacing intervals based on the regulatory speed limit of the roadway prior to beginning any work. When a work zone traffic control plan or a work zone traffic control standard drawing is not provided to indicate the spacing intervals for a typical 3 advance warning sign array installation, utilize the sign placement intervals below. **These sign intervals do not apply to the sign intervals of the advance sign intervals for standard lane closures.**

ADVANCE WARNING SIGN PLACEMENT INTERVALS	
URBAN / RURAL (LOW SPEED) ≤ 35 MPH	200 / 200 / 200 Feet
URBAN / RURAL (INTERMEDIATE SPEED) 40 - 50 MPH	350 / 350 / 350 Feet
RURAL (HIGH SPEED) ≥ 55 MPH	500 / 500 / 500 Feet
INTERSTATE	1000 / 1500 / 2600 Feet

LANE CLOSURE RESTRICTIONS –

The Department prohibits the Contractor from conducting work within the limits of a paved shoulder or median areas on primary routes during any time of the day that traffic volumes exceed 800 vehicles per hour per direction as determined by the Engineer. The Department reserves the right to suspend a lane closure if any resulting traffic backups are deemed excessive by the Engineer. Maintain all lane closure restrictions as directed by the plans, these special provisions, and the Engineer.

LANE CLOSURE RESTRICTIONS - (EXTENDED HOLIDAY PERIODS) -

The Department reserves the right to restrict the installation of lane closures on interstates and high volume primary routes when the presence of a lane closure will seriously hinder normal traffic flow during extended holiday periods. An extended holiday period is hereby defined as those days preceding and following the holiday that experience significant increases in the volume of traffic due

to the holiday as determined by the Department. Also, the Department reserves the right to increase an extended holiday period if excessive traffic disruptions occur during those days prior to and after the established extended holiday period. Extended holiday periods include but are not limited to the week of Easter, the week of Thanksgiving, the weeks before and after the 4th of July, and the weeks before and after Christmas. The Department recommends the Contractor submit inquiries to the Engineer regarding specific days of an extended holiday period 90 days prior to the holiday. The Contractor should make these inquiries annually due to the progressive nature of the calendar.

The specific days and dates listed below are modifications to sub-section 601.1.3 of the 2007 Standard Specifications for Highway Construction and apply to this project.

The District Engineering Administrator may reduce or extend the extended holiday lane closure prohibitions listed below as necessary.

EXTENDED HOLIDAY LANE CLOSURE PROHIBITIONS	
HOLIDAY	DURATION
EASTER	10:00 AM SUNDAY PRIOR – 6:00 AM TUESDAY AFTER
JULY 4 TH	NO LESS THAN 7 DAYS PRIOR – NO LESS THAN 7 DAYS AFTER (Specific Dates Per Engineer) (Recommend Contractor request specific dates 90 days prior)
THANKSGIVING	10:00 AM SUNDAY PRIOR – 6:00 AM TUESDAY AFTER
CHRISTMAS	NO LESS THAN 7 DAYS PRIOR – 6:00 AM JANUARY 3 RD (Specific Dates Per Engineer) (Recommend Contractor request specific dates 90 days prior)

SHOULDER CLOSURE RESTRICTIONS -

The Department prohibits the Contractor from conducting work within 15’ of the near edge of the adjacent travel lane on the outside shoulders or the median areas under a shoulder closure during any time that traffic volumes exceed 800 vehicles per hour per direction. The hourly restrictions for lane closures shall also apply to work activities conducted under a shoulder closure within 15’ of the near edge of an adjacent travel lane or a median area. The Department reserves the right to suspend work conducted under a shoulder closure if any traffic backups develop and are deemed excessive by the Engineer. Maintain all shoulder closure restrictions as directed by the plans, these special provisions, and the Engineer.

On interstate highways, the Department prohibits the Contractor from conducting work within the limits of a paved shoulder or within 10’ of the near edge of an adjacent travel lane under a shoulder closure. All work that may require the presence of personnel, tools, equipment, materials, vehicles, etc., within the limits of a paved shoulder or within 10’ of the near edge of an adjacent travel lane shall be conducted under a lane closure.

On primary and secondary roadways, the Department prohibits the Contractor from conducting work within 1' or less of the near edge of an adjacent travel lane under a shoulder closure. All work that may require the presence of personnel, tools, equipment, materials, vehicles, etc., within 1' of the near edge of an adjacent travel lane shall be conducted under a lane closure.

The Contractor shall install all shoulder closures as directed by the typical traffic control standard drawings designated for shoulder closures, and the Engineer. Substitution of the portable plastic drums with oversized cones during nighttime shoulder closures is PROHIBITED.

TYPICAL TRAFFIC CONTROL STANDARD DRAWINGS -

The typical traffic control standard drawings of the "Standard Drawings For Road Construction", although compliant with the MUTCD, shall take precedence over the MUTCD. The typical traffic control standard drawings of the "Standard Drawings For Road Construction" shall apply to all projects let to contract.

a) ADDENDUMS

Traffic Control Pay Items

(Addendums to the "2007 Standard Specifications for Highway Construction")

(A) Trailer-Mounted Changeable Message Signs -

Sub-section 606.5 Measurement (paragraph 2) -

Trailer-mounted changeable message signs are included in the lump sum item for Traffic Control in accordance with **Subsections 107.12** and **601.5** of the "2007 Standard Specifications for Highway Construction". No separate measurement will be made for trailer-mounted changeable message signs unless the contract includes a specific pay item for trailer-mounted changeable message signs.

The Contractor shall provide, install, operate, and maintain the trailer-mounted changeable message sign per traffic control set-up as directed by the Plans, the "Standard Drawings for Road Construction", these Special Provisions, the Specifications, and the Engineer.

Sub-section 606.6 Payment (paragraph 2) -

In addition to **Subsections 107.12** and **601.6**, the payment for Traffic Control is full compensation for providing, installing, removing, relocating, operating, and maintaining trailer-mounted advance warning arrow panels and trailer-mounted changeable message signs as specified or directed and includes providing the units' primary power source; repairing or replacing damaged or malfunctioning units within the specified time; providing traffic control necessary for installing, operating, and maintaining the units; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other items of the Contract.

Sub-section 606.6 Payment (paragraph 3) -

Disregard this paragraph unless the Contract includes a specific pay item for trailer-mounted changeable message signs.

(B) Construction -

Sub-section 601.4.2 Construction Vehicles (paragraph 2) -

When working within the rights-of-way of access-controlled roadways such as Interstate highways, the Contractor's vehicles may only change direction of travel at interchanges. These vehicles are prohibited from crossing the roadway from right side to median or vice versa. Use a flagger to control the Contractor's vehicles when these vehicles attempt to enter the roadway from a closed lane or the median area. Ensure that the flagger does not stop traffic, cause traffic to change lanes, or affect traffic in any manner. The Contractor's vehicles may not disrupt the normal flow of traffic or enter the travel lane of the roadway until a sufficient gap is present.

The Contractor shall have flaggers available to control all construction vehicles entering or crossing the travel lanes of secondary and primary routes. The RCE shall determine the necessity of these flaggers for control of these construction vehicles. The RCE shall consider sight distance, vertical and horizontal curves of the roadway, prevailing speeds of traffic, frequency of construction vehicles entering or crossing the roadway, and other site conditions that may impact the safety of the workers and motorists when determining the necessity of these flaggers. Ensure that these flaggers do not stop traffic, cause traffic to change lanes, or affect traffic in any manner. The Contractor's vehicles may not disrupt the normal flow of traffic or enter the travel lane of the roadway until a sufficient gap is present.

(C) Category I Traffic Control Devices –

***** (Effective on all projects let to contract after May 1, 2010) *****

Sub-section 603.2.2 Oversized Traffic Cones (paragraph 6) -

Reflectorize each oversized traffic cone with 4 retroreflective bands: 2 orange and 2 white retroreflective bands. Alternate the orange and white retroreflective bands, with the top band always being orange. Make each retroreflective band not less than 6 inches wide. Utilize Type III – Microprismatic retroreflective sheeting for retroreflectorization on all projects let to contract after May 1, 2010 unless otherwise specified. Separate each retroreflective band with not more than a 2-inch non-reflectorized area. Do not splice the retroreflective sheeting to create the 6-inch retroreflective bands. Apply the retroreflective sheeting directly to the cone surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting.

Sub-section 603.2.3 Portable Plastic Drums (paragraph 3) -

Reflectorize each drum with Type III – Microprismatic retroreflective sheeting: 2 orange and 2 white retroreflective bands, 6 inches wide on all projects let to contract after May 1, 2010 unless otherwise specified. Alternate the orange and white retroreflective bands with the top band always being orange. Ensure that any non-reflectorized area between the orange and white retroreflective bands does not exceed 2 inches. Do not splice the retroreflective sheeting to create the 6-inch retroreflective bands. Apply the retroreflective sheeting directly to the drum surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting.

(D) Truck-Mounted Attenuator –

Sub-section 605.4.2.2 Truck-Mounted Attenuators (paragraph 6) -

Attach each truck-mounted attenuator to the rear of a truck with a minimum gross vehicular weight (GVM) of 15,000 pounds (actual weight). If the addition of supplemental weight to the vehicle as ballast is necessary, contain the material within a structure constructed of steel. Construct this steel structure to have a minimum of four sides and a bottom. A top is optional. Bolt this structure to the frame of the truck. Utilize a sufficient number of fasteners for attachment of the steel structure to the frame of the truck to ensure the structure will not part from the frame of the truck during an impact upon the attached truck mounted attenuator. Utilize either dry loose sand or steel reinforced concrete for ballast material within the steel structure to achieve the necessary weight. The ballast material shall remain contained within the confines of the steel structure and shall not protrude from the steel structure in any manner.

MAINTENANCE OF OPERATION

Existing traffic signals shall **REMAIN IN OPERATION** until the new/modified installation has been satisfactorily tested, and it has been placed in operation after approval by the engineer. The Testing shall be accomplished without hazard to the traveling public and while the signal heads are suitably **BAGGED WITH BURLAP**. All signal heads in place, but not in use, shall be covered with **BURLAP**.

NOTE: PLASTIC BAGS ARE NOT ACCEPTABLE.

After approval is received from the Engineer, the new signal heads shall be switched into service during that controller phase being displayed by the existing equipment; and the existing equipment shall be turned off simultaneously. Immediately after the new signal equipment has been made operational, the existing signal heads shall be turned off, and removed.

The Contractor is cautioned to PLAN their work, to cause minimum interference with any existing signal operation. Adjustments in the existing equipment made necessary by the new installation, will be made at the expense of the Contractor.

The Contractor shall retain ownership of the materials and equipment after the intersection has been made operational, until Inspection and Acceptance (either partial or final) has been made by the Engineer. Prior to Acceptance, if the materials or equipment is damaged by whatever cause, the Contractor shall be responsible for repair or replacement.

The contractor shall be responsible for the maintenance and operation of all existing signals in the "LIST OF PROJECT TRAFFIC SIGNALS" from the date of the "NOTICE TO PROCEED" of the contract until the final acceptance of the project. This shall include all daily maintenance of signals and any emergencies which may arise. For emergency response times see "ADJUSTMENT OF SIGNAL EQUIPMENT" Specification. A maintenance response personnel list shall be submitted by the contractor at the pre-construction meeting and approved by the DEPARTMENT.

Unless otherwise provided, Maintenance of Operation of existing traffic signals will not be paid directly, but will be paid for under the item, Temporary Adjustment of Traffic Signal Equipment. This payment shall include and be full compensation for all labor, equipment, tools and incidentals necessary to complete the work.

TEMPORARY ADJUSTMENT OF TRAFFIC SIGNAL EQUIPMENT AND TIMINGS

DESCRIPTION - This work consists of the Temporary Adjustment of traffic control signal equipment, materials and timings, during the construction of this project. Highway construction often features new road alignment, a new cross section (widening), and a change in grade. Sometimes the maintenance of traffic requires the relocation of an intersection, or the installation of a temporary "construction" traffic signal. Relocation of signal equipment may also be required to avoid interference with heavy equipment. This item has been established to cover the equipment, materials, and labor that may be required to temporarily adjust the physical location of traffic signal features, such as poles, controller, steel cable, electrical cable, signal heads, etc. This item is also used to cover the installation and removal of a TEMPORARY CONSTRUCTION SIGNAL.

The intersections or locations for Temporary Adjustment are shown on the Plans, or stated in a "List Of Intersections". After all Temporary Adjustments have been made, and after the road construction has been completed, the final result shall be the traffic signals shown in the Plans.

The amount of work required by this item will vary greatly between projects. The Bidder/Contractor should carefully study the Road Plans, the staging of work, and the Signal Plans, to estimate the work required.

1. GENERAL -

1.1 Companion Specifications -

Several Specifications directly pertain to this subject: "REMOVAL, SALVAGE, AND DISPOSAL"; and "MAINTENANCE OF OPERATION"; and should be studied.

1.2 Continuity Of Signal Operation -

1.2.1 The Maintenance of Traffic (as provided in the Traffic Control Plan), and the SAFETY OF TRAFFIC is of prime importance. Safety will be enhanced by providing for the continuous operation of traffic signals. Signals shall NOT be arbitrarily turned off for the convenience of the CONTRACTOR. Instead, the adjusted, temporary signal shall be constructed, and the operation smoothly transferred to that signal. When the Engineer gives permission to briefly turn off a signal, complete intersection control using a flagger and/or Police traffic direction shall be provided.

1.2.2 Unless otherwise stated on the Plans, "fixed time" operation of actuated signals is permissible when the old loop detectors are abandoned. Likewise, it is permissible to adopt "uncoordinated" operation of adjacent signals, when the old interconnection cable has been broken. If possible, the District Traffic Engineer should be requested to provide temporary controller time settings for these conditions.

These temporary time settings may occur throughout the project life and therefore the contract will be paid for each site visit as necessary by bid item: **Temporary Timing Adjustment Per Site Visit**; and this work shall include all intersections needing timing adjustments per site visit. Site shall be defined as project limits.

1.2.3 At a CRITICAL INTERSECTION as designated by the Engineer or stated on the Plans, full Continuity of Operation shall be provided; and shall include the installation of a temporary Controller at the adjusted location, and transferring operation to it, simultaneously turning off the old controller.

1.2.4 If shown on the Plans, or stated in the Special Provisions, the CONTRACTOR shall provide SPECIAL DETECTION SYSTEMS to provide semi- or full-actuation of a Controller. If required, Special Detection may include Microwave, Infrared, sonic, or video camera detection. The equipment shall be NEW, and shall be installed and aimed per the manufacturer's specifications.

1.2.5 The appearance of temporary signals shall be fully professional. Signal heads shall be placed at the proper HEIGHT above the road, and at the correct ALINEMENT with lanes of traffic, and at the proper DISTANCE from the stop line (see MUTCD).

1.2.6 Temporary equipment shall be fully reliable, fully functional, and of good appearance.

1.3 Coordination Of Work -
The CONTRACTOR is advised to completely coordinate work between sub-contractors, and to carefully stage the project to minimize the work required by this item.

1.4 Final Configuration -
Signal equipment that has been relocated or adjusted shall be considered as "temporary". The CONTRACTOR shall plan and stage the work so that the end result is a traffic signal installation conforming to the plans and using all NEW equipment.

2. OPERATION, MAINTENANCE AND EMERGENCY SERVICE -

The contractor shall be responsible for the maintenance and operation of all existing signals in the "LIST OF PROJECT TRAFFIC SIGNALS" from the date of the "NOTICE TO PROCEED" of the contract until the final acceptance of the project. This shall include all daily maintenance of signals and any emergencies which may arise. The CONTRACTOR is also responsible of the liability for proper and safe operation of each signal. Herein, this activity will be termed "Maintenance".

2.1 Restriction -
The CONTRACTOR shall not change the phasing or other operation of a signalized intersection without Departmental approval.

2.2 New Signals -
Signals installed by the CONTRACTOR shall be Maintained by the CONTRACTOR until the Department formally accepts the work.

2.3 Requirements -
The CONTRACTOR shall perform EMERGENCY REPAIRS AND SERVICES as required, to insure continuity of operation of listed traffic signals and associated equipment. **This shall include re-placement of burned out lamps.**

2.3.1 Technician. The CONTRACTOR shall provide at least one (1) qualified LOCAL signal technician, subject to call at all times, to provide emergency services as required to assure continuous and efficient operation of signal installations and systems. This shall include non-business hours, weekends, and holidays. The Technician shall be fully qualified to trouble-shoot, service, repair and/or replace traffic controllers and components, both electro-mechanical and solid-state. At the PRE-CONSTRUCTION CONFERENCE, the CONTRACTOR shall furnish the RCE with a LIST OF THE SIGNAL TECHNICIANS who will be responsible for performing the emergency service, and the LOCAL PHONE NUMBER(S) of the CONTRACTOR's agent(s) (answering service, etc.), who will receive emergency calls during and after the CONTRACTOR's normal business hours.

2.3.2 Repair Time. **The CONTRACTOR shall be ON-SITE of the malfunctioning signal for emergency service within the maximum time listed in the following schedule-**

<u>Weekdays or Saturday</u>	<u>Maximum Time</u>
6 AM to 6 PM	1 hour
6 PM to 6 AM	4 hours
<u>Sundays or Holidays</u>	
Day or Night	4 hours

2.3.3 Restoration of Normal Service. Once the CONTRACTOR has started repair work/emergency service, the CONTRACTOR shall restore a malfunctioning signal to normal phase operations uninterrupted.

2.3.4 Time Changes (EST/DST). As part of Maintenance, the CONTRACTOR shall reset all time clocks to local legal time.

2.3.5 Records. The CONTRACTOR shall maintain a LOG of all trouble calls received, the response time, and the corrective action taken. The records and logs shall be available to Department personnel for review during normal working hours. All records and logs shall be turned over to the Department at FINAL ACCEPTANCE.

2.4 Failure To Perform - In the event the CONTRACTOR fails to perform in accordance with requirements and schedules of this Specification, the Department reserves the right, without notice to the CONTRACTOR, to engage a Third Party to perform the maintenance and emergency service necessary to assure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option, shall be deducted from the payment due the CONTRACTOR, plus a FIVE HUNDRED (\$500) DOLLAR PENALTY FOR EACH OCCASION, FOR EACH DAY (UNTIL CORRECTED). The penalty shall be forfeited as liquidated damages.

3. SPECIFIC ITEMS -

3.1 Possession -

All TEMPORARY signal heads, signs, and poles shall revert to the CONTRACTOR at the end of the Project. All temporary NEW Controllers and Cabinets, and NEW Special Detectors shall revert to the Department or to the Jurisdiction at the end of the project.

3.2 Controllers and Cabinets -

For safety and reliability, ALL CONTROLLERS AND CABINETS, that are in continuous service for seven (7) or more days, SHALL BE NEW, AND SHALL BE COMPATIBLE WITH THE CONTROLLER TYPE (NEMA or 170) AND THE MANUFACTURED BRAND, USED BY THE JURISDICTION IN WHICH THE PROJECT OCCURS. The CONTRACTOR shall have in possession and shall furnish sufficient Controllers and Cabinets to provide Continuity Of Operation. The CONTRACTOR shall also provide, with each temporary Cabinet, sufficient Detector Amplifiers, Load Switch Packs, DC Isolators, relays, etc. to operate each intersection properly.

3.3 Signal Heads -

The CONTRACTOR shall provide sufficient 300 mm (12 inch) vehicle and pedestrian traffic signal heads to provide Continuity Of Operation. Signal heads shall be of the same configuration as that being replaced (e.g. 5-section). Signal heads shall be LED or fully lamped; 300 mm (12 inch) heads with 135 watt bulbs (or the Krypton filled watt-saver equivalent). Signal heads not in use shall be covered with a burlap bag. Signal heads shall be shifted side-to-side to be over traffic lanes as they are opened or closed to traffic.

3.4 Poles -

The location of temporary and final signal poles shall be approved by the Engineer.

3.5 Joint Use Poles -

Poles used for traffic signals, are often owned and used by other overhead cable utility companies. Full coordination and cooperation with those utilities shall be maintained when staging the signal work. The CONTRACTOR shall furnish the temporary and final wood poles as necessary for Continuity Of Operation. Back Guys shall be provided for wood poles, sufficient to keep the pole vertical.

3.6 Detector Loops -

Final Detector Loops shall only be installed after completion of all work activities which might damage the loops. Detector Loops may more conveniently be installed in the base paving course, and covered with the final surface. It is preferred that loops be paved over rather than installed in saw cuts upon completion of paving.

3.7 Miscellaneous Equipment -

Minor equipment may be RE-USED in temporary adjusted configurations, but not in the final configuration. This includes steel cable, electrical cable, conduit, pedestrian buttons and signs, concrete pads, and spliceboxes/pullboxes/handboxes not utilized in the new signalization. The CONTRACTOR shall furnish sufficient steel cable and electrical cable to provide Continuity of Operation.

3.8 Signs -

Highway signs on existing steel cable (span wires), shall be transferred to the Adjusted spans, and placed in the same physical alinement. The Contract will usually specify new signs for the final configuration. (Ground mounted signs are covered in Section 107.11 of the STANDARD SPECIFICATIONS.)

3.9 Electric Service -

The CONTRACTOR shall install temporary electric service(s) as necessary to operate the signal(s). Coordination with the local power company and with the Engineer is the responsibility of the CONTRACTOR, as are all permits or licenses.

4. **METHOD OF MEASUREMENT** -

4.1 Basis -

The Temporary Adjustment of traffic signals will not be measured, but will be paid for on a LUMP SUM BASIS for the contract; for which the CONTRACTOR shall provide all signal materials and related equipment, and shall adjust these features as often as necessary during the course of the project, coordinating with other construction.

4.2 Estimate -

To prepare their cost estimate, the CONTRACTOR should develop an assessment of the work required over the life of the Contract, for EACH INTERSECTION shown on the "List of Intersections", or listed as a Temporary Construction Signal. The LUMP SUM is the total of these prices.

5. **BASIS OF PAYMENT** -

The Temporary Adjustment of traffic signals, measured as described above, shall be paid at the Contract price bid for--

TEMPORARY ADJUSTMENT OF TRAFFIC SIGNAL EQUIPMENT--LUMP SUM

Payment for Temporary Adjustment (T.A.) shall be made according to the same Schedule as shown in the Specification "Traffic Control Plan", namely:

% Contract Complete:	1-5%	6-15%	16-29%	30-49%	50-69%	70-89%	90-100%
% Payment for T.A.:	20%	40%	60%	70%	80%	90%	100%

The price and payment for adjusting traffic signal equipment shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals to perform the work as specified.

FURNISH AND INSTALL ELECTRICAL CONDUIT

DESCRIPTION - This work shall consist of furnishing and installing Electrical Conduit and fittings of the types and sizes specified herein, at locations shown on the Plans, or as established by the Engineer in accordance with these Specifications. All materials will be subject to inspection for condition by the Engineer, just prior to incorporation into the work.

1. **MATERIALS** -

Materials shall meet the requirements listed below:

1.1 Steel Conduit -

Steel electrical conduit shall be rigid, heavy-wall, galvanized steel, meeting the requirements of Federal Specification WW-C-581, and American Standards Association Specifications USAS C-80.1-1966.

1.2 PVC Conduit -

Plastic conduit shall be sunlight resistant Polyvinyl chloride (PVC), SCHEDULE 80, meeting the requirements of National Electrical Manufacturing Association (NEMA) Specification TC-2 and Underwriter Laboratory (UL) standards UL-514; and/or ASTM D-1784. Fittings shall meet NEMA TC-3 and UL-514.

1.2.1 HDPE Rolled Conduit – (High Density Polyethylene)

Underground cables can be installed in rolled conduit, directional bored (Trenchless) as an acceptable alternative. This conduit shall be a minimum of SCHEDULE 80. It shall be buried at a minimum of 18" depth.

1.3 Flexible Weather-Tight Steel Conduit -

Weather-Tight/liquid-tight flexible steel electrical conduit shall be single strip, helically wound, interlocking galvanized steel. It shall be made liquid-tight by an extruded polyvinyl chloride jacket; and shall meet the requirements of UL-360.

1.4 Fittings -

All Conduit Bodies, 90° Bends, Weatherheads, elbows, nipples, couplings, and other hardware shall be made of the same material and quality as the conduit run and shall be incidental to conduit installation.

1.5 The CONDUIT JUNCTION BOX (for some roadside detector loop installations), shall be a non-metallic PVC molded junction box with a weather tight screw-down cover, of nominal size 150 x 150 x 100D mm (6 x 6 x 4D inches). It shall be incidental to conduit installation. Unless shown mounted on a pole, it shall be installed in the dirt, at the depth of the conduit run, and covered with earth.

1.6 Ground Bushings -

Grounding Bushings shall be threaded, made of malleable iron, galvanized steel, or brass; and shall have an insulating plastic insert, and lay-in lugs to hold No. 6 AWG copper wire.

1.7 Pulling Line -

The Pulling Line shall be Polypropylene Rope, having a minimum tensile strength of 1000 Newtons (240 pounds), which SHALL BE PULLED INTO ALL UNDERGROUND CONDUIT RUNS, AND SHALL REMAIN THEREIN FOR FUTURE USE.

1.8 Warning Tape -

Underground Warning Tape shall be Heavy duty B-720 polyethylene, 0.89 mm (3.5 mils) thick, by 76 mm (3 in) wide, with APWA color RED, for electric lines. The Tape shall be PLACED ABOVE ALL TRENCHED CONDUIT RUNS, just before the final back-fill.

1.9 Tracer Wire –

When conduit is used exclusively for Fiber Optic communication cable, a minimum 14 Ga. Tracer Wire shall be installed inside conduit.

1.10 Concrete -

Concrete used for patching pavement shall be DOT STANDARD SPECIFICATION CLASS X according to Sections 701,702,703, and 704.

1.11 Bituminous Asphalt -

Bituminous Asphalt for patching pavement shall be DOT STANDARD SPECIFICATIONS, Section 403.

2. CONSTRUCTION METHODS -

2.1 General -

Conduit shall be installed as either a Riser, or be Trenched, or Directional Bored.

2.2 Plans -

ALL CONDUIT SHALL BE INSTALLED AND PAID AS TRENCHED OR RISER UNLESS SPECIFICALLY SHOWN ON THE PLANS AS DIRECTION BORED.

2.3 Depth -

Unless shown otherwise, conduits shall be placed a minimum depth of eighteen (18) inches below surface grade, and shall slope at a minimum rate of 150 mm (6 in.), per 30 metres (100 ft.) of length, to a splice box/junction box hole or drain. All conduit runs shall be cleaned and swabbed before cables are installed. In poles, cabinets, and buildings, DUCT-SEAL shall be used to effectively seal the opening.

2.4 Direction -

Changes in direction of conduit shall be accomplished by the use of standard bends, elbows, or by bending the steel conduit. Steel conduit, if bent, shall have a uniform radius which will fit the location, with a minimum radius of six (6) times the internal diameter of the pipe. Sharp kinks in the conduit or the substitution of unlike materials will not be permitted.

2.5 Fittings -

Standard manufactured conduit bodies, condulets, Weatherheads, elbows, nipples, tees, reducers, bends, couplings, unions, etc., of the same materials and treatment as the straight conduit, shall be used as required throughout the conduit line. All fittings shall be tightly connected to the conduit. A SOLVENT-WELD CEMENT shall be used for fitting connections with PVC conduit. Where steel conduit mates PVC, an adapter coupling shall be used and sealed waterproof.

2.6 Cutting -

Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where it is necessary to cut and thread steel conduit, no exposed threads will be permitted. All conduit fittings shall be free from burrs and rough places; and all cut conduits shall be reamed before fittings and cables are installed. All conduit runs ending in a junction box, hand box, or other approved junction point, shall be provided with a bushing to protect the cable from abrasion. Conduit being placed for future use, shall be capped.

2.7 Location -

Where conduit passes under a curb, an 'X' shall be cut in the curb, over the conduit. Where there is no curb, a stake shall be driven in the ground at the end of the conduit to mark its location. Where conduit is placed in a signal pole foundation for future use, an 'X' shall be cut to indicate the side the conduit enters.

2.8 Risers -

Conduit Risers shall be attached to wood poles; or where specified, to the outside of steel poles. Stainless Steel bands shall be used for steel poles. Conduit clamps/straps and galvanized screws shall be used on wood poles. Attachment shall be in accordance with the Design Details, the Standards, or the Plans. Each Riser shall be furnished with a Weatherhead, which shall not be measured.

2.9 Trenching (Non-Paved Surface) -

Trenches shall be excavated to such depth as necessary to provide 18 inches minimum cover over the conduit. Cinders, broken concrete, or other hard abrasive materials will not be permitted in the back-filling. The trench shall be free of such materials before the conduit is placed. No conduit shall be placed prior to inspection by the Engineer. Back-Fill shall be compacted, and the surface restored.

2.10 Trenching (In Paved Surface) -

Trenches across driveways or streets shall be cleanly saw cut about 150 mm (6 inches) wide. The conduit shall be placed and the back-fill shall be compacted, and the patch shall be of like material and thickness as was removed. NO additional payment shall be made for the bituminous or concrete patching material, unless a pay item has been established for such.

2.11 Bored and Jack (Pushing) -

Where shown on the Plans as Bored Or Jacked, certain steel conduit to be placed under existing roadways, driveways, sidewalks, or other paved surfaces, shall be BORED AND JACKED. Such conduit shall be placed by jacking, boring, pushing, or other means approved by the Engineer, without cutting or removing pavement.

2.12 Trenchless (Directional Bored) -

When the signal design anticipates that HIGH-ACCURACY DIRECTIONAL BORING techniques will be used, and the conduit pulled back through the bore, then a pay item will be established for: SCHEDULE 80 PVC CONDUIT (TRENCHLESS). The Directional Boring method shall be approved by the Engineer, and shall in no way crumple or damage the conduit. An acceptable alternative material can be SCHEDULE 80 HDPE Rolled Conduit – (High Density Polyethylene).

2.13 Placed Before Pouring -

Where shown on the Plans, PVC conduit, with Flexible Weather Tight conduit, shall be placed in roadways or structures, prior to pouring the concrete. Typical usage would be a bridge deck. The conduit shall be firmly attached to the bottom reinforcement bar mat, or to the bottom wire-mat, using plastic tie-wraps every 0.60 metre (2 feet). At expansion joints, 1.2 metre (4 foot) lengths (typical) of Flexible Weather Tight steel conduit shall be used to accommodate movement. These shall be installed to NEC standards for concrete structural installations and usage, including any recommended lubricants and sleeves. All conduit ends etc. shall be plugged to prevent concrete penetration. When used on a bridge, there will usually be splice-box(es) near the center line, and the conduit will terminate in hand-boxes at each end.

2.14 Restoration -

The Contractor shall restore all cuts, trenches, and openings to the original condition. Grass surfaces shall be replaced with pre-grown, cut turf (sod), in existing lawns. Other dirt areas shall be raked, seeded, and fertilized. While care should have been used to avoid them, any damaged trees and shrubs shall be replaced (if directed by the Engineer).

3. METHOD OF MEASUREMENT -

3.1 Electrical Conduit will be measured by the LINEAR FOOT (METRE), for the type, size, and method of installation specified, along the center line of the conduit from end to end, including trenched, risers, and bored-and-jacked.

3.2 Conduit Bends, Conduit Bodies, (condulets), 90° bends, elbows, conduit junction boxes for detector loops, miscellaneous fittings, couplings, WEATHERHEADS, adapters, bushings, locknuts, and other items shall be incidental to conduit installation and shall NOT be measured.

3.3 Unless otherwise specified, trenching, back-filling, and patching will NOT be measured for payment.

4. BASIS OF PAYMENT -

Accepted quantities of electrical conduit, measured as provided above, will be paid for at the Contract unit price bid for:

For conduit either Trenched or Riser:

___ IN.(MM) GALVANIZED RIGID CONDUIT -- LINEAR FOOT (METRE)

___ IN.(MM) PVC SCHEDULE 80 CONDUIT -- LINEAR FOOT (METRE)

For bored and jacked:

___IN.(MM) GALVANIZED RIGID CONDUIT
(BORED AND JACKED) -- LINEAR FOOT (METRE)

For high accuracy directional boring:

___IN.(MM) PVC SCHEDULE 80 PVC CONDUIT
(TRENCHLESS) -- LINEAR FOOT (METRE)

For flexibility:

___IN.(MM) FLEXIBLE GALVANIZED STEEL CONDUIT
- WEATHER-TIGHT -- LINEAR FOOT (METRE)

which shall be full compensation for furnishing and placing all materials, fittings, equipment, labor, and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL ELECTRICAL CABLE

DESCRIPTION - This work shall consist of furnishing and installing traffic signal, loop lead-in, pedestrian signal, and pedestrian push button Electrical Cable of the size and type shown on the Plans, or as established by the Engineer, in accordance with these Specifications.

1. MATERIALS -

Materials shall meet the requirements listed below:

1.1 Traffic Signal Wiring -

1.1.1 **BLACK** - Unless specified elsewhere, the **traffic signal cable** shall be four pairs(8 conductor). The conductor shall be #14 AWG, 19 strands, bare copper. The conductor insulation shall be high density polyethylene and shall be both ultraviolet and weather resistant. The wall thickness shall be 0.016 inch minimum point thickness. A polyethylene filler material shall be utilized to produce a circular cross section with a polypropylene rip cord under the external jacket for easy removal. The conductor cable assembly shall be wrapped with a 0.001 inch clear mylar binder applied helically with a minimum 25% overlap. The overall cable assembly shall be provided with a high density polyethylene jacket which is both ultraviolet and weather resistant. The wall thickness shall be 0.032 inch minimum point thickness. Traffic signal cable shall be manufactured in accordance with the requirements of Underwriters' Laboratories, Federal specifications, and the National Electric Code.

1.1.2 Each cable run shall have the number of conductors indicated in the Standards, the Design Details, the Plans, or the WIRING DIAGRAM. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.

1.1.3 A separate cable shall be run for each phase or approach. (See TYPICAL WIRE & CABLE USAGE sheet.)

1.1.4 The list below is a guide to general usage--

Signal: Jumpers	4 pair (8 conductor)BLACK
Signal: To Each Approach	4 pair (8 conductor)BLACK

1.1.5 The traffic signal cable must also meet or exceed specifications in the chart below.

Conductor Insulation Pair Color	External Jacket Insulation Color	Size,AWG
White-Yellow Red-Green White w/Black Band-Yellow w/Black Band Red w/Black Band-Green w/Black Band	Black	#14

1.2 Loop lead-in Wiring -

1.2.1 **GRAY** - Unless specified elsewhere, the **loop lead-in cable** shall be four pairs(8 conductor). Each pair shall be individually twisted (two turns per foot minimum). Outside diameter shall be 0.60 inch maximum. The conductor shall be #14 AWG, 19 strands, bare copper. The conductor insulation shall be high density polyethylene and shall be both ultraviolet and weather resistant. The wall thickness shall be 0.016 inch minimum point thickness. Each pair shall be wrapped with a 0.001 inch aluminum shield with a minimum 25% overlap. Aluminum is to be located on the outside. A polyethylene filler material shall be utilized to produce a circular cross section with a polypropylene rip cord under the external jacket for easy removal. The drain wire shall be #16 AWG, 19 strands, tinned copper. The conductor cable assembly shall be wrapped with a 0.001 inch clear mylar binder applied helically with a minimum 25% overlap. The overall cable assembly shall be provided with a high density polyethylene jacket which is both ultraviolet and weather resistant. The wall thickness shall be 0.032 inch minimum point thickness. Traffic signal cable shall be manufactured in

accordance with the requirements of Underwriters' Laboratories, Federal specifications, and the National Electric Code.

1.2.2 Each cable run shall have the number of conductors indicated in the Standards, the Design Details, the Plans, or the WIRING DIAGRAM. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.

1.2.3 A separate cable should be run to each corner of the intersection. (See TYPICAL WIRE & CABLE USAGE sheet.)

1.2.4 The list below is a guide to general usage--

Loop: To Each Corner 4 pair (8 conductor)GRAY

1.2.5 The twisted pair loop lead-in cable must also meet or exceed specifications in the chart below.

Conductor Insulation Pair Color	External Jacket Insulation Color	Size,AWG
White-Yellow Red-Green White w/Black Band-Yellow w/Black Band Red w/Black Band-Green w/Black Band	Gray	#14

1.3 Pedestrian Signal / Push Button Wiring -

1.3.1 **BLACK** - Unless specified elsewhere, the *pedestrian signal cable* shall be two pairs(4 conductor). The conductor shall be #14 AWG, 19 strands, bare copper. The conductor insulation shall be high density polyethylene and shall be both ultraviolet and weather resistant. The wall thickness shall be 0.016 inch minimum point thickness. A polyethylene filler material shall be utilized to produce a circular cross section with a polypropylene rip cord under the external jacket for easy removal. The conductor cable assembly shall be wrapped with a 0.001 inch clear mylar binder applied helically with a minimum 25% overlap. The overall cable assembly shall be provided with a high density polyethylene jacket which is both ultraviolet and weather resistant. The wall thickness shall be 0.032 inch minimum point thickness. Traffic signal cable shall be manufactured in accordance with the requirements of Underwriters' Laboratories, Federal specifications, and the National Electric Code.

1.3.2 **GRAY** - Unless specified elsewhere, the *pedestrian push button cable and loop lead-in* to each pole shall be two pairs(4 conductor). Outside diameter shall be 0.38 inch maximum. The conductor shall be #14 AWG, 19 strands, bare copper. The conductor insulation shall be high density polyethylene and shall be both ultraviolet and weather resistant. The wall thickness shall be 0.016 inch minimum point thickness. Each pair shall be wrapped with a 0.001 inch aluminum shield with a minimum 25% overlap. Aluminum is to be located on the outside. A polyethylene filler material shall be utilized to produce a circular cross section with a polypropylene rip cord under the external jacket for easy removal. The drain wire shall be #1 AWG, 19 strands, tinned copper. The conductor cable assembly shall be wrapped with a 0.001 inch clear mylar binder applied helically with a minimum 25% overlap. The overall cable assembly shall be provided with a high density polyethylene jacket which is both ultraviolet and weather resistant. The wall thickness shall be 0.032 inch minimum point thickness. Traffic signal cable shall be manufactured in accordance with the requirements of Underwriters' Laboratories, Federal specifications, and the National Electric Code.

1.3.3 Each cable run shall have the number of conductors indicated in the Standards, the Design Details, the Plans, or the WIRING DIAGRAM. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.

1.3.4 A separate cable should be run for each phase or approach. (See TYPICAL WIRE & CABLE USAGE sheet.)

1.3.5 The list below is a guide to general usage--

Pedestrian Signal	2 pair (4 conductor)BLACK
Pedestrian Push Button	2 pair (4 conductor)GRAY
Loop Lead-in	2 pair (4 conductor)GRAY

1.3.6 The traffic signal cable must also meet or exceed specifications in the chart below.

Conductor Insulation Pair Color	External Jacket Insulation Color	Size,AWG
White-Yellow Red-Green	Black	#14
White-Yellow Red-Green	Gray	#14

1.4 Electrical Service Cable -
See FURNISH AND INSTALL ELECTRICAL SERVICE.

1.5 Loop Detector Wire -
See FURNISH AND INSTALL LOOP DETECTORS.

1.6 Communication Cable -
See FURNISH AND INSTALL COMMUNICATION CABLE.

2. CERTIFICATION -

2.1 The CONTRACTOR SHALL FURNISH design details in sufficient detail for complete evaluation of the Proposal and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing.

NOTE: CATALOG CUTS ARE REQUIRED.

3. WARRANTY -

The Contractor shall furnish the Engineer with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.

4. LABELING AND DELIVERY -

4.1 The Manufacturer shall mark each cable and cable-reel to facilitate easy identification of the various sizes.

4.2 The cable shall be supplied in reels of sufficient length to assure splice-free installation.

5. CONSTRUCTION METHODS -

5.1 Field Wiring -

5.1.1 All cable runs shall be SPLICE-FREE. All connections shall be made at terminal blocks, or in the controller cabinet.

5.1.2 All field wiring shall be in accordance with applicable Electrical Codes--National, State, and Local. Where required, arranging for PERMITS and/or electrical INSPECTION is the responsibility of the Contractor.

5.1.3 At each splicebox, strain pole base, and cabinet, at least One metre (3 ft.) of cable slack shall be provided. The slack shall be neatly coiled, and bound with a nylon tie.

5.1.4 At the cabinet end, each cable shall be labeled, using nylon cable markers, and indelible pen. The Phase and/or Approach (NB, EB, etc) shall be shown.

5.1.5 Cabinet connections shall correspond to the COLOR-CODE shown on the TYPICAL WIRE & CABLE USAGE sheet; (green wire to green signal circuit, etc). **NOTE: ALL WIRES SHALL BE TERMINATED IN EACH SIGNAL HEAD.**

5.1.6 The entire length of cables damaged during installation, shall be replaced, without further cost to the Department.

5.1.7 All electrical cable installed in conduit shall be drawn in place, free from electrical and mechanical injury. When a lubricating agent is needed, a wire pulling compound compatible with the cable insulation shall be used.

5.1.8 Vertical cable runs mounted on the outside of poles shall be installed in conduit of the type shown on the Design Details or in the Standards.

5.1.9 Weather service heads shall be used wherever electrical cable directly enters a strain pole or a vertical conduit run.

5.1.10 Drip loops of at least 20 cm (8 in.) shall be provided at all overhead entrance points such as signal heads, strain poles, or weather heads.

5.2 Conduit -

All conduit and elbows shall be installed as described in the appropriate Specification (e.g. FURNISH AND INSTALL ELECTRICAL CONDUIT; FURNISH AND INSTALL LOCAL CONTROLLERS AND CABINETS; FURNISH AND INSTALL STRAIN POLES; etc.)

6. METHOD OF MEASUREMENT -

With the exception of the electrical service cable, electrical cable lengths of the size and numbers of conductors specified, shall be measured by the LINEAR FOOT (METRE) as actually furnished and installed, completely in place and accepted, with each size cable being a separate pay item.

7. BASIS OF PAYMENT -

These items, measured as provided above, will be paid for at the Contract unit price bid for:

NO. 14 AWG COPPER WIRE ___ CONDUCTOR, (COLOR) --LIN. FT.

which shall be full compensation for furnishing all material, labor, equipment, and incidentals necessary for furnishing and installing cable as specified.

FURNISH AND INSTALL COMMUNICATION CABLE

DESCRIPTION - This item shall consist of furnishing and installing voice-grade, twisted-pair, telephone-type Communication Cable of the size and type as shown on the Plans or as directed by the Engineer, in underground conduit, conduit risers, and/or overhead, complete with all necessary hardware as required.

1. MATERIALS AND EQUIPMENT -1.1 General -

The cable and installation shall comply with applicable National specifications, such as the National Electrical Code (NEC); also, the International Municipal Signal Association (IMSA) standards.

1.2 Self-Supporting Voice-Grade Communication Cable - OVERHEAD

SHALL BE IMSA STANDARD 40-4.

Electrical cable supplied under this Specification shall be figure-eight, self-supporting cable that shall include a 6 mm (1/4 in.) diameter, galvanized-stranded-messenger cable with a minimum tensile strength of 28912 Newtons (6,500 pounds) that is integrated into the outer cable jacket. The messenger cable shall support a polyethylene-jacketed, copper-shielded, voice grade cable rated at 300 volts, containing ** twisted-pairs of No. 19 AWG, solid copper conductors which are insulated with polyethylene and are color coded.

1.3 UNDERGROUND Voice-Grade Communication Cable -

SHALL BE IMSA STANDARD 40-6.

Electrical cable supplied under this Specification shall be polyethylene jacketed, copper-shielded, voice grade cable rated at 300 volts, containing ** twisted-pairs of No. 19 AWG solid copper conductors which are insulated with polyethylene and are color coded.

** The NUMBER OF TWISTED PAIRS shall be as specified on the Plans or the Bid.

1.4 Usage -

The cables specified above may be used with either low voltage telephone level signals, or may be used with 115 VAC interconnection circuits used with pre-timed controllers.

1.5 Supporting Hardware -

For overhead installation standard telecommunications industry, non-corroding hardware shall be used to attach the cable to utility or other poles. Cable suspension clamps shall be designed for "Figure Eight" cable, shall have a "J-hook" for installation convenience, and shall include a thru-bolt of the size and length required by the utility company. The suspension clamp shall be appropriate to the "turning angle" of the cable at that point of the installation, including the use of corner suspension clamps where necessary. Deadends shall be used as necessary.

1.6 Electrical Conduit -

Where required, all conduit and fittings supplied shall be in accordance with the Specification, FURNISH AND INSTALL ELECTRICAL CONDUIT.

2. CERTIFICATION -

2.1 The CONTRACTOR SHALL PROVIDE certified TEST RESULTS from the Manufacturer, showing that the cable to be furnished has passed all IMSA specified tests. The Manufacturer shall agree to provide the Engineer free-access to the factory to observe the manufacturing process.

2.2 The CONTRACTOR SHALL FURNISH design details and shop drawings in sufficient detail for complete evaluation of the cable and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing.

NOTE: CATALOG CUTS ARE REQUIRED**3. WARRANTY -**

The CONTRACTOR shall furnish the Engineer with any warranties on equipment and material that are provided by the Manufacturer or Vendor, as normal trade practice.

4. LABELING AND DELIVERY -

4.1 Unless otherwise stated, the cable shall be supplied in minimum reels of 750 metres (2,500 ft.), for splice-free installation.

4.2 The Manufacturer shall be required to mark each cable and cable reel to facilitate easy identification of the various sizes when stored in stockpiles.

5. CONSTRUCTION METHODS -

5.1 Communication cable shall be installed where, and in the manner indicated on the Plans, or as directed by the Engineer. The attached color code shall be followed.

5.2 Underground -

When installed underground, all communication cable will be installed in conduit, of the size and type shown on the Plans.

5.2.1 Ducts. When cable is pulled through Ducts or Manholes, the installation shall be performed ACCORDING TO UTILITY COMPANY SPECIFICATIONS, IN DESIGNATED DUCTS, WITH A UTILITY COMPANY INSPECTOR STANDING BY. Lateral runs shall be made to Controller or Splice Cabinets. No splices shall be made in a Utility Company manhole.

5.2.2 Existing conduits or ducts shall be reamed prior to use.

5.2.3 In manholes, cable shall be wrapped with plastic tracer tape, and shall also be tagged with indelible label similar to "LOW VOLTAGE TRAFFIC SIGNAL CABLE".

5.2.4 At completion, Ducts shall be sealed/plugged per Utility Company requirements.

5.3 Overhead -

When overhead installation is shown on the Plans, self-supporting cable shall be used according to the following--

5.3.1 Where shown on the Plans, overhead communications cable shall be installed on wood poles. Cables shall be attached to utility poles by means of standard hardware as shown on the Plans and IN ACCORDANCE WITH THE REQUIREMENTS OF THE OWNER (UTILITY COMPANY).

5.3.2 Unless stated by the Utility Company, attachments to utility poles shall be made a minimum of 3 metres (10 ft.) below primary electrical cables or other facilities carrying 750 volts or more. A minimum vertical clearance of 5.5 metres (18 feet) above Interstate and arterial highways shall be maintained.

5.3.3 Vertical cable runs mounted on the outside of poles shall be installed in proper conduit risers (see FURNISH AND INSTALL ELECTRIC CONDUIT).

5.3.4 Where shown on the Plans, communications cable may be installed overhead between an splice cabinet and a controller cabinet, via existing strain poles and signal span wire. The locations involved are shown on the Plans. Cable Supports attached to the span wire, shall be used.

5.4 Splices -

CABLE RUNS SHALL BE SPLICE-FREE. Splices shall only be allowed ABOVE GROUND, in either CONTROLLER CABINETS, or SPLICE-CABINETS, or SAMPLING STATIONS, or AERIAL TERMINAL BOXES as shown on the plans.

5.5 Connections -

5.5.1 In controller-, splice-, and sampling station-cabinets, and aerial terminal boxes, the cables shall be connected to firmly mounted terminal blocks. Terminal Blocks shall be telephone quality, R66 "Quick-Connect M-type", having ** pairs capability, and use a "Stand-Off Mounting".

5.5.2 Connection shall also be made to cables/harnesses required by the Remote Communication Unit (RCU), or sampling station detectors, per Manufacturers instructions.

5.5.3 Grounding and/or lightning protection shall be installed, in accordance with the requirements of the controller or modem Manufacturer, and shall be incidental to this item. If directed by the Manufacturer, the UN-USED PAIRS of the communication cable shall be connected to ground at one or more point(s).

At each cabinet, communication cable shielding shall be grounded to the earth ground system.

5.5.4 Testing. The CONTRACTOR IS COMPLETELY RESPONSIBLE FOR TESTING THE COMMUNICATION CABLE SYSTEM. Following complete installation and connection of the communication cable, it shall be tested BY THE CONTRACTOR; from INTERSECTION TO INTERSECTION, and THE ENTIRE LENGTH from the FIRST TO LAST INTERSECTION. Surge protection shall be disconnected during some tests, and then reconnected. During some tests, the communication lines shall be disconnected from the 170 controller. Tests performed by the CONTRACTOR shall include:

A. A high-impedance FET voltmeter shall be connected to each pair, to determine if stray DC/AC voltages are present.

B. An insulation resistance test shall be performed, using a portable hand-held "Megger". Tests shall be performed between pairs, and to ground. The resistance shall be greater than 10 meg-ohm at 500 V.

C. An attenuation test shall be performed. The technician shall "Ring-Out" each twisted pair for continuity test, recording the round trip loop resistance, which shall be less than 60.6 ohm per kilometre (18.5 ohms per 1000 feet).

D. A sound powered telephone shall be connected to each pair, one by one. The quality of transmission shall be recorded on a scale of 1 to 5 (five being the best).

E. If necessary, the CONTRACTOR shall be prepared to fully trouble-shoot the cable system in the event of problems, using a computer type DIGITAL TEST INSTRUMENT, and/or an oscilloscope.

5.5.5 Test . Tests shall be witnessed by the Engineer.

6. INCIDENTALS -

6.1 Weather (Service) heads shall be used wherever the cable directly enters a strain pole or a vertical conduit riser run.

6.2 Drip Loops of at least 20 cm (8 inches) shall be provided at all overhead entrance points such as strain poles and vertical conduits.

6.3 Slack shall be provided at pull boxes, splice boxes, interconnect cabinets, controller cabinets and other junction points. One metre (3 ft.) of cable slack shall be provided, neatly coiled, tied-off, and positioned in the bottom of the enclosure.

6.4 All electrical cable pulled in conduit shall be drawn in place, free from electrical or mechanical injury. When a lubricating agent is needed, a wire-pulling compound compatible with the cable insulation shall be used.

7. METHOD OF MEASUREMENT -

7.1 Communications cable, of the type and size specified, will be measured by the LINEAR FOOT (METRE) of cable actually furnished and installed, completely in place and accepted. Each cable size shall constitute a separate pay item, where indicated.

7.2 Aerial Terminal Boxes shall be NOT be measured, but are required, and shall be considered incidental to overhead cable installation.

7.3 NOTE: Electrical conduit, pull boxes, splice cabinets, and steel span wire are listed elsewhere as separate pay items.

8. BASIS OF PAYMENT -

8.1 Communications cable measured as provided above and accepted will be paid for at the unit price bid per linear foot (metre) for:

ELECTRICAL COMMUNICATION CABLE - (OVERHEAD/UNDERGROUND)
** -PAIR -- LINEAR FT. (METRE)

8.2 Aerial Terminal Boxes shall NOT be paid, but shall be considered incidental to the installation of Overhead Communications cable.

Such payment shall be full compensation for furnishing all material, labor, hardware, equipment and incidentals necessary for furnishing and installing communications cable and completing the work as specified.

FURNISH AND INSTALL FIBER OPTIC CABLE

Description - This item shall consist of installing and/or furnishing single-mode fiber optic (SMFO) cable in conduit and risers or overhead lashed to new messenger cable. The CONTRACTOR shall furnish all attachment hardware and installation guides necessary to install the fiber optic cable.

1.0 Materials -

1.1 The cable shall meet all requirements stated in RUS-90 as well as those stated within this specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Utility Service as meeting the requirements of RUS-PE-90. The cable shall be new, unused, and of current design and manufacture.

The single-mode fiber used in the cable shall conform to the following specifications:

Typical Core Diameter:	8.3 μm
Cladding Diameter:	125.0 \pm 1.0 μm by fiber end measurement
Core-to-Cladding Offset:	\leq 1.0 μm
Cladding Non-Circularity:	< 2.0% (Defined as: [1-(min. cladding dia. max. cladding dia.)] x 100)
Coating Diameter:	250 \pm 15 μm
Attenuation Uniformity:	No point discontinuity greater than 0.1 dB at either 1300 nm or 1550 μm .

The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.40 dB/km at 1550 nm and 0.5 at 1310 nm, with 80% of the measured values no greater than 0.10 dB/km at 1550 nm.

The maximum dispersion shall \pm 3.3 ps/(nm • km) for 1285 nm through 1330 and shall be \leq 18 ps/(nm • km) at 1550 nm.

1.2 Fiber Characteristics -

All fibers in the cable shall be usable fibers and meet required specifications.

All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements to this specification.

Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

The coating shall be a dual-layered, UV cured acrylate applied by the fiber manufacturer. The coating shall be capable of being mechanically or chemically striped without damaging the fiber.

1.3 Specification of Cables -

Optical fibers shall be placed inside a loose buffer tube.

Two (2) buffer tubes, each containing six (6) single-mode fibers shall be furnished. The fibers shall not adhere to the inside of the buffer tube. Each buffer tube shall contain six (6) fibers.

Each fiber shall be distinguishable from each other by means of color coding according to the following.

1. Blue
2. Orange
3. Green
4. Brown

5. Slate
6. White

These colors shall meet EIA/TIA-598, "*Color Coding of Fiber Optic Cables*".

Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors according to the following.

1. Blue
2. Orange
3. Green
4. Brown
5. Slate
6. White
7. Red
8. Black
9. Yellow
10. Violet
11. Rose
12. Aqua

These colors shall meet EIA/TIA-598, "*Color Coding of Fiber Optic Cables*".

Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

Each buffer tube shall be filled with a non-hygroscopic, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional non-toxic solvents.

Buffer tubes shall be stranded around a central member using the reverse oscillation, or "SZ" stranding process.

Binders shall be supplied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tube. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

The cable shall contain a central member that is intended to prevent buckling of the cable. The central anti-buckling member shall consist of a glass reinforced plastic rod.

The cable shall contain at least one (1) ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength aramid yarns and fiberglass. The high tensile strength aramid yarns/fiberglass shall be vertically stranded evenly around the cable core. All cable shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The jacket or sheath shall be free of holes, pits and blisters.

The jacket shall have "Grabber" brand cable (stock No. VF0G – 07) markers. The markers shall be 6 inches long, orange in color and read as follows in black: "SCDOT TRAFFIC SIGNAL FIBER OPTIC CABLE". The cable markers shall be placed on each side of every pole approximately 2 feet from the pole. The contractor shall install three additional markers on the cable between the poles spaced equally apart along the span.

The maximum pulling tension shall be 2700 N (600 lbs.) during installation (short-term) and 600 N (135 lbs.) long-term installed.

The shipping, storage, installation and operating temperature range of the cable shall be –40° C to 70° C.

1.4 Quality Assurance Provisions -

All optic fibers shall be proof tested by the fiber manufacturer at a minimum load of 50 kpsi.

All optical fibers shall be 100% attenuation tested by the manufacturer. The attenuation of each fiber shall be provided with each cable reel.

2.0 Certification -

2.1 The contractor shall provide certified test results from the manufacturer showing the cable furnished has been tested. The CONTRACTOR SHALL FURNISH design details in sufficient detail for complete evaluation of the Proposal and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing.

NOTE: CATALOG CUTS ARE REQUIRED.

3.0 Labeling and Delivery -

The SMFO cable furnished by the CONTRACTOR shall be packaged on non-returnable wooden reels. The reels shall not contain imperfections such as broken flanges or nails that may cause damage to the cable as it is unreeled.

Both the top and bottom ends of the cable shall be available for testing on the reel. The ends of the cable shall be sealed to prevent the ingress of moisture.

Each cable reel shall have a durable weatherproof label that shows the actual length of cable on the reel.

The SMFO cable shall be spliced only at those points shown in the PLANS. The designated splices are the fiber interconnect centers that are proposed for installation in each controller cabinet. The CONTRACTOR shall order cable in reel lengths that are of sufficient length to require no intermediate splicing of the cable.

4.0 Construction Methods -

4.1 General -

The CONTRACTOR shall take every precaution to ensure the fiber optic cable is not damaged during storage and installation. The fiber optic cable shall not be stepped on by workers nor run over by any vehicle or equipment. The fiber optic cable shall not be pulled along the ground or over or around obstructions.

It shall be the responsibility of the CONTRACTOR to coordinate his overhead and underground construction activities on a continuing basis with each of the utility agencies which have facilities in the immediate vicinity.

The fiber optic cable shall be installed in conduit with other cables only where specifically called out in the PLANS.

Where fiber optic cable is to be installed on overhead poles, the CONTRACTOR shall exercise care in temporary placement of installation equipment to provide safety to the public and to prevent damage to existing facilities. Should the CONTRACTOR cause damage to any existing cables and/or equipment, the CONTRACTOR shall immediately notify the ENGINEER and the affected owner and the CONTRACTOR shall repair or have the repair made at no additional cost.

During installation, the CONTRACTOR shall provide cable blocks at least every 50 feet to guide the cable and reduce pulling tension. All pulling equipment and hardware that will contact the cable during installation must maintain the minimum bend radius of the fiber optic cable as listed in Table 1. Corner blocks, appropriately sized to ensure that the minimum bending radius of the cable is maintained, shall be provided whenever fiber optic cable must be pulled around a corner.

Table 1

Fiber Optic Minimum Bend Radius Chart

Nominal Cable Diameter		Minimum Bend Radius (No Tension) Installed		Minimum Bend Radius (Under Tension)	
Millimeters	Inches	Centimeters	Inches	Centimeters	Inches
6.0 – 10.0	(1/4 – 3/8)	10.0	(4.0)	15.0	(6.0)
10.1 – 15.0	(4/10 – 6/10)	15.0	(6.0)	22.5	(9.0)
15.1 – 20.0	(10/16 – 8/10)	20.0	(8.0)	25.0	(10.0)
20.1 – 23.0	(13/16 – 9/10)	23.0	(9.0)	25.0	(10.0)
23.1 – 25.0	(15/16 – 1.0)	25.0	(10.0)	30.0	(12.0)

Fiber optic cable runs shall be continuous between allowable splice points in the fiber interconnect centers cabinet splice points. The CONTRACTOR shall carefully determine the length of fiber optic cable necessary to reach from termination point to termination point. Splicing of fiber optic cable in conduit, pole bases, manholes, pull boxes, or aerial locations shall not be permitted.

Fiber optic cable shall not be pulled through any intermediate junction box, manhole, pull box, pole base or any other opening in the conduit unless specifically required by the ENGINEER in specific facilities. The necessary length of cable to be installed shall be pulled from one junction box, manhole, pull box, pole base, or cabinet to the immediate next downstream manhole, box, pole base, or cabinet. The remaining length of cable to be installed in the next conduit shall be carefully stored in a manner that is not hazardous to pedestrian or vehicular traffic yet ensures that no damage to the cable shall occur. The cable shall be stored in a manner that shall allow that length of cable to be safely pulled into the next conduit. The ENGINEER shall approve the storing methods to be used.

Cable reel lagging shall remain on the cable reels until they arrive at the pulling site. If the lagging has been removed, the CONTRACTOR shall securely fasten the cable ends to avoid damage during transit.

If the cable must be unreeled during installation, the “figure-eight” configuration shall be used to prevent kinking or twisting of the fiber optic cable. The preferred size of the “figure-eight” is 15 feet with each loop about eight (8) feet in diameter. The fiber optic cable shall not be coiled in a continuous direction except for lengths of 100 feet or less.

The CONTRACTOR shall not increase the tension on the messenger cable to which the fiber optic cable has already been lashed.

At the completion of a day’s installation, the CONTRACTOR shall protect the cable from the ingest of moisture by placing a cable cap and/or several wraps of tape on the tip of the cable.

The CONTRACTOR shall record the cable meter marks at every other pole location and at the fiber splice points on a set of as-built plans. Two (2) copies of the plans showing the meter marks shall be provided to the RCE. The meter marks are most easily obtained while forming drip loops.

The CONTRACTOR shall route the fiber optic cable on the inside of messenger intersections at dead ends and crossovers.

4.2 Aerial Installation -

4.2.1 General - Where the plans call for aerial installation, the CONTRACTOR shall furnish new messenger cable (see Furnish and Install Steel Cable) and shall lash the fiber optic cable to the new messenger.

Aerial cable shall be installed either manually or by using the moving reel method. If the CONTRACTOR proposes to use the moving reel method, the CONTRACTOR shall submit to the RCE the cable manufacturer's recommended procedures for this installation technique at least seven (7) days prior to beginning the installation of the fiber optic cable.

The required clearances between the fiber optic cable and the utility features shall be maintained as follows unless otherwise noted on the PLANS:

A minimum of 4 inches vertical clearance and 12 inches minimum total (diagonal) separation shall be maintained to the telephone and/or cable vision facilities.

A minimum of 40 inches vertical clearance shall be maintained to all electrical transformers.

A minimum of 40 inches vertical clearance shall be maintained to all electric lines (including street light circuits).

Relocation of overhead utilities will be made by others and is not a part of this Contract.

Where called for on the PLANS or as directed by the ENGINEER, fiberglass extension arms shall be furnished and utilized to install the new fiber optic cable. Such fiberglass extension arms shall be an MIF PH6-2 or approved equal.

Where called for on the PLANS, the CONTRACTOR shall install down guys, sidewalk guys, and aerial guys as shown in the typical diagrams in the PLANS. Guy guards shall be constructed of #18 hot-dipped galvanized steel. All guy hardware shall be on the same bolt with the J-hook.

The CONTRACTOR shall use a Kellems® (or approved equal) grip wire mesh pulling grip and swivel to prevent damage to the cable during cable pulls.

The CONTRACTOR shall provide drip loops for the fiber optic cable at all utility poles to which the fiber optic cable is attached. The drip loops must be of the "smooth-curve" type and shall be at least of the recommended dimensions for a drip loop in the typical details. Drip loops shall be formed by hand or by using an expansion loop-forming tool. Straps and spacers shall be used to support the cable in the absence of lashing wire support and to hold the cable bundles together. The strap and spacer shall be installed no closer than four (4) inches to the first bend in the drip loop.

Where called for on the PLANS, the CONTRACTOR shall install backlashes in the Fiber Optic cable as necessary. The CONTRACTOR shall utilize 16" Fiber Optic Strand Storage Bracket (Multilink model number 2116-SSPTB or approved equivalent) which are also known as "Fiber Optic Sno Shoes". All hardware necessary for the installation of the backlash including the "Fiber Optic Sno Shoes", and lashing of the additional cable shall be incidental to the cost of Furnishing and Installing the Fiber Optic cable.

The straps and spacers used for drip loops and other fiber optic cable handling purposes shall be hand-tight only. The strap and spacer must be loose enough to allow longitudinal travel by the cable, but tight enough to prevent the strap and spacer from moving on the messenger cable.

4.2.2 Lashing - The fiber optic cable shall be overlashed to the new messenger installed by the CONTRACTOR. The lashing shall be accomplished with aluminum wrapping tape spaced at intervals not exceeding 380 mm or with 1.5 mm (minimum) diameter galvanized steel spiral cable wrap. Wrapping tape, if used shall be 1.3 mm x 7.6 mm. At least four (4) turns shall be used. Lashing shall be accomplished in the manner that results in the wire and the cable appearing to be an integral part of the support cable. Fiber optic cable shall be installed without loose lashing, twisting or weaving along the messenger.

The CONTRACTOR shall terminate the lashing wire with a lashing wire clamp as the cable run is lashed up, span-by-span. The lashing wires shall be terminated as follows:

- Place a cable spacer between the fiber optic cable and the messenger.

- Locate lashing wire clamp 2" from strap and spacer. Pull enough lashing wire out of lasher to terminate into the lashing wire clamp.
- Wrap the lashing wire three (3) times around only the messenger between the lashing wire clamp and the planned location of the first wrap around both the strand and fiber optic cable.
- Secure the lashing wire as shown in the typical details.

4.3 Underground Installation -

Where shown on the PLANS, the fiber optic cable shall be installed in new underground conduit and risers.

Seven (7) days prior to the installation of fiber optic cable in conduit is performed, the CONTRACTOR shall provide the RCE with four (4) copies of the cable manufacturer's recommended and maximum pulling tensions. Included with these pulling tensions shall be a list of the cable manufacturer's approved pulling lubricants. Only those lubricants in the quantity recommended by the fiber optic cable manufacturer, shall be approved for use.

When installing the cable in underground conduit, the maximum allowable pulling tension for the cable installation by the CONTRACTOR shall not exceed 70 percent of the manufacturer's maximum pulling tension. If the cable is pulled by mechanical means, a dynamometer (clutch device) approved by the ENGINEER shall be used to ensure that a maximum allowable pulling tension is not exceeded at any time during installation.

Fiber optic cable shall not be pulled over edges or corners, over or around obstructions or through unnecessary curves or bends. Approved cable guides, feeders, shoes and bushings shall be used to prevent damage to the cable during installation.

Sealing bushings rather than weatherheads shall be used on all risers containing fiber optic cable. The sealing bushings shall conform to the typical detail shown.

Conduit bends and cabinet entrance fittings used by the fiber optic cable network shall be designed to accommodate the bending radius limitations of the fiber optic cable used.

The CONTRACTOR shall pull an adequate amount of fiber optic cable into the controller cabinet to perform splicing and to provide approximately 50' of slack cable (approximately 25' from the entering and 25' from the exiting cable). After the fiber optic cable has been spliced, the cable shall be neatly coiled (with tie-wraps placed on the cable) and placed on top of the fiber interconnect center or on the bottom of the cabinet. The cable shall be readily accessible to enable maintenance personnel to perform splicing of the cable in a vehicle located near the controller cabinet.

5.3.1 Grounding and Bonding - All metal conduit shall be grounded.

All conduit, terminal cabinets, anchor bolts and reinforcing bar cages shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. The grounding or bonding conductor shall be #6 AWG bare stranded copper wire.

Bonding of metallic conduit in pull boxes and other installations, where the conduit is not coupled, shall be coupled with metallic conduit ground bushings having smoothly rounded molded insulated inserts and bonding jumpers.

The CONTRACTOR shall furnish and install all grounding facilities.

5.0 Construction Methods -

5.1 Fiber optic cable, of the type and size specified will be measured by the linear foot of cable actually furnished and installed, completely in place and accepted, using an "OTDR" (optical time-domain reflectometer).

5.2 Note that electrical conduit, splice boxes, splice cabinets, and steel span wire are listed elsewhere as separate pay items.

6.0 Basis of Payment -

6.1 Fiber optic cable measured as provided above and accepted will be paid for at the unit price bid per linear foot for installing and/or furnishing:

**FURNISH AND INSTALL FIBER OPTIC CABLE
INSTALL FIBER OPTIC CABLE**

Such payment shall be full compensation for furnishing all material, labor, hardware, equipment and incidentals necessary for furnishing and installing communications cable and completing the work as specified.

FURNISH AND INSTALL FIBER INTERCONNECT CENTERS

1.0 Description - This item shall consist of installing and/or furnishing fiber interconnect centers. Included in this item is the splicing of the fiber optic cable; furnishing and installing splice trays, interconnection sleeves, jumpers, connectors and other hardware that may be needed for connecting the fiber optic cable to the signal system electronic devices.

2.0 Materials -

The CONTRACTOR shall furnish and install rack-mounted fiber optic interconnect centers into the new and reused type-170 cabinets at the locations shown on the PLANS. The fiber interconnect cabinet shall include strain relief hardware, be rack mountable, have the capacity for four (4) splice trays and termination/connection capacity for 24 fibers in four (4) modules. The cabinet shall be a **Siecor Fiber Distribution Center (FDC-005)** or approved equivalent.

The fiber interconnect center shall be installed by the CONTRACTOR in the new, or reused controller cabinet. The fiber interconnect center shall be located in the cabinet such that the slack fiber optic cable stored on top of the fiber interconnect center (as required in the special provision – Furnish and Install Fiber Optic Cable) can be easily removed (along with the fiber interconnect center) from the cabinet and taken to a maintenance vehicle for splicing, if necessary.

The interconnect center shall be equipped with fiber connector panels with twelve (12) factory-installed interconnection sleeves. The interconnection panels shall be clearly labeled (transmit/receive). The interconnection sleeves shall be types ST compatible, with ceramic insert, and composite housing for single-mode fiber optic cable.

Each interconnect center shall be furnished with three (3) splice trays. The trays shall be capable of accepting twelve (12) fusion and six (6) mechanical splices. The tray shall be a **Siecor type M67-045** or approved equivalent.

The CONTRACTOR shall furnish pigtail fiber optic cable assemblies with type ST compatible connectors factory-installed on one (1) end of the assembly. The pigtails shall be fusion-spliced to the fiber optic communication cable in splice tray #1. Twelve (12) pigtail assemblies shall be furnished and installed in each fiber interconnect center.

3.0 Splicing of the Fiber Optic Cable -

3.1 Splicing Methods -

All splicing shall be done by means of a fusion splice technique, which induces less than 0.3 dB attenuation. Bare fibers shall be completely recoated with a protective RTV gel or similar substance prior to application of the sleeve or housing to protect the fiber from scoring, dirt, or microbending. Each spliced fiber shall be packaged in a heat shrink protective sleeve or housing. All splices shall be performed in accordance with the cable manufacturer's and the splice manufacturer's recommendations. During splicing, the CONTRACTOR shall maintain the continuity of the buffer tube and fiber color.

Incoming fibers shall be provided with five (5) feet of coiled slack and spliced to a pigtail of the same type fiber. Pigtails shall have a minimum length of five (5) feet and shall have a factory-installed ST compatible connector. The pigtails shall have an attenuation of less than 0.3 dB. The ST connector shall mate with the connector panels installed in the fiber interconnect center.

Unused optical fibers shall be properly protected with sealed end caps.

The CONTRACTOR shall record the meter marks on the cable sheath at each splice point. These marks shall be provided to the owner on a sheet of as-built system plans at the completion of the project.

3.2 Jumpers -

The CONTRACTOR shall furnish and install single-mode fiber optic cable assemblies with connectors factory-installed on each end (jumpers). These assemblies will be used to connect the fiber optic modem to the connector panel. These jumpers will not be paid for directly but shall be considered incidental to the item Furnish and Install Fiber Optic Modem.

3.3 Future Applications -

The fiber optic communications network is being designed and constructed to accommodate future applications. As shown in the typical details, all six (6) fibers in one (1) buffer tube of the entering cable shall be fusion spliced through to the six (6) fibers in one (1) of the buffer tubes leaving the cabinet. The continuity of the buffer tube and fiber color shall be maintained. These fibers shall be spliced in a separate splice tray. The cable entering and exiting the cabinet will contain another buffer tube that contains six (6) fibers. Three (3) of the incoming and three (3) of the outgoing fibers shall be fusion spliced to pigtail assemblies with factory-installed type ST compatible connectors. These six (6) splices shall be placed in a second splice tray. The remaining three (3) incoming and three (3) outgoing fibers shall be fusion spliced to pigtail assemblies with factory-installed type ST compatible connectors and placed in a third tray. All pigtail assemblies shall be connected by the CONTRACTOR to the connector panels installed in the Fiber Interconnect Center. The Transmit and Receive designations of each fiber pair shall be clearly labeled on the front of the connector panel. Each fiber termination/connection shall be tested for attenuation.

4.0 Method of Measurement -

This item shall include the labor, equipment, and materials necessary to install the fiber optic interconnect centers in accordance with the PLANS and Project Special Provisions. This item shall be measured by the number of each installed.

5.0 Basis of Payment -

The fiber interconnect center, as measured above, will be paid for at the contract unit price bid for:

**FURNISH AND INSTALL FIBER INTERCONNECT CENTER – EACH.
INSTALL FIBER INTERCONNECT CENTER – EACH.**

The bid for the interconnect center shall include the cost of installing and/or furnishing the fiber interconnect centers into the signal controller cabinets and making the necessary connections. The fusion splicing of the cable, furnishing and installing the splice trays, pigtail assemblies, connector panels and interconnection sleeves shall be considered incidental to this item and will not be paid directly.

FURNISH AND INSTALL FIBER OPTIC MODEMS

1.0 Description - The Optical Transceiver shall electrically interface with an Electronic Industries Association (EIA) RS-232 C/D compatible computer equipment communications port and convert the signals to an optical, intensity modulated form supporting communications over single-mode, optical fiber at a 1300 nanometer (nm) nominal wavelength. Electrically transmitted signals shall be converted to optically modulated signals. Optically modulated signals received by the optical transceiver shall be demodulated and converted to electrical signals for transfer to the attached computer or controller device via the electrical RS-232 interconnection.

The Optical Transceiver (OTR) to support multi-dropped communications must include an optical repeating capability. Thus, the device is designated OTR-Repeating or "OTR/RP". The OTR/RP shall receive an uplink signal and shall not only drop the signal as electrical to the attached computer or controller but it shall also repeat the signal to the attached, downlink device. The attached computer will be programmed to respond to its address, thus providing multi-dropped link management. The OTR/RP shall repeat both uplink received signals and downlink received signs to provide communications continuity. Both uplink received and downlink received signals shall be demodulated, converted to RS-232 compatible electrical signals and transferred to the attached controller via the RD-232 interface.

In summary, the OTR/RP must:

- A. Bidirectionally communicate with compatible up and downlink OTR(s).
- B. Repeat uplink received signals to the downlink connected OTR.
- C. Demodulate any received optical signal and provide the signal in electrical form to an attached controller via an RS-232 connection. Convert an electronically received signal from an attached controller via the RS-232 connection and optically transmit the signal to any uplink and downlink attached OTR(s).

The OTR/RP shall be compatible with non multi-dropped OTR(s) which support multi-dropped link origination and termination. The OTR/RP shall apply to multi-drop connected controllers which require optical repeating capability.

2.0 Materials -

2.1 Electrical Interface -

The OTR/RP shall receive 24 VAC power from a step down transformer supplied with the unit. The OTR/RP shall require no more than 350 ma peak load current, which shall be supplied by a 500 ma or greater step down transformer. The transformer shall receive 110 VAC \pm 15%, 60 Hz \pm 10% prime power from a utility power strip within a controller cabinet. A three (3) prong, standard power connector shall be provided with the transfer. The 24 VAC power cable from the transformer to the OTR/RP shall be a minimum of six (6) feet and terminated with a compatible female connector or with leads prepared for easy attachment to a terminal block on the OTR. A DB-9 power connector is preferred; however, a terminal block is acceptable.

OTR/RP circuitry shall be designed to operate with 24 VAC voltage fluctuations of \pm 15%. Where over or under voltage conditions exist out of the operating range of the OTR/RP, circuitry shall protect the OTR/RP electronics from damage. The OTR/RP shall automatically recover from an over or under voltage condition when the input power returns to the normal operating range.

The OTR/RP shall be interconnected to a computerized controller through an RS-232 C/D interface channel. A DB-255 connector shall be provided to accommodate the electrical communications interface. EIA RS-232 interconnect standards as presented in Table 3.1.2-1 shall be accommodated as applicable. The "request to send" and "clear to send" signals shall be utilized to control transmission. Full duplex asynchronous data transmission shall be accommodated by the design.

Signal ground shall be accommodated on Pin 7 of the DB-25S connector. Chassis ground shall be accommodated on Pin 1 of the DB-25 connector and Pin 1 of the DB-9 connector. There shall be no internal connection between signal ground and chassis ground. For any metallic cable interconnection with the OTR/RP design, a means of protecting electronics from lightning shall be included

The RS-232 electrical interface shall be capable of operating at data rates of 1200, 2400, 4800, 9600, 19.2 kB, 38.4 kbps, up to a minimum of 50 kbps.

2.2 Optical Interface -

The optical interface to the OTR/RP shall be single-mode fiber, 8.3 \pm 0.5 microns, via FCPC connectors. Mode fields of either depressed cladding or matched cladding shall be accommodated by the connector in accordance with the following:

- A) Depressed Clad Mode Field = 8.8 \pm 0.5 micron
 B) Matched Clad Mode Field = 10.5 \pm 1 micron

Female connectors shall be provided on the OTR/RP device as follows:

- A) Transmit uplink
 B) Transmit downlink
 C) Receive uplink
 D) Receive downlink

**Table 3.1.2-1
 Optical Transceiver Interconnect**

				EIA RS-232 C RS-232 D	
	Description	Abbr.	Direction of Signal to	Circuit	25 Pin
GROUND	Protective Ground (Shield)			AA	1
	Signal Ground (Common return)	SG		AB	7
	DTE Common return				N/A
	DCE Common return				N/A
DATA	Transmitted Data	TD	DCE	BA	2
	Received Data	RD	DTE	BB	3
CONTROL	Request to Send	RTS	DCE	CA	4
	Clear to Send	CTS	DTE	CB	5
	Data Set Ready	DSR	DTE	CC	6
	Data Terminal Ready	DTR	DCE	CD	20
	Data Carrier Detect	DCD	DTE	CF	8
	Ring Indicator	RI	DTE	CE	N/A
TIMING	Transmit Clock (from DTE)	TTC	DCE	DA	N/A
	Transmit Clock (from DCE)	TC	DTE	DB	N/A
	Receive Clock (from DCE)	RC	DTE	DD	N/A
TESTS	Remote Digital Loopback V.54/2	RLB	DCE	RL	N/A
	Local Analog Loopback V.54/3	LLB	DCE	LL	N/A
	Test Mode	TM	DTE	TM	25
	SOURCES		EIA RS-232		ISO 2110

Notes:

1. DB-25S Connector
2. Wire per International Systems Organization (ISO) Standard 2110 as indicated.
3. N/A = Not Applicable to the OTR/RP
4. Signals may be interconnected as required by the OTR/RP to accomplish communications.

A minimum of four (4) fiber optic FCPC interconnections shall be provided. The fiber optics transmitter and fiber optics receiver devices shall operate at 1300 nm, nominal. Transmitter launch power shall be a minimum of -15 dBm. The optical receiver shall be capable of receiving a -30 dBm signal providing a bit error rate not exceeding 1 error in 10^9 bits. When a fiber optics transmitter and receiver are interconnected via a single-mode fiber, a link loss of 15 dB minimum shall be accommodated to 100% confidence level, while providing communications in conformance with this specification.

The OTR/RP circuitry shall be capable of receiving electrical digital data up to 50 kbps and converting the electrical bit stream to an intensity-modulated optical signal launched at a minimum of -15 dBm (minimum) in both the upstream and downstream directions (i.e. via both transmit fibers). Similarly, the OPR/RP circuitry shall have the capability of receiving an intensity-modulated optical signal at modulation rates of 50 kbps or less, at a minimum signal level of -30 dBm and;

- A) Demodulate the optical signal and convert the signal to an equivalent electrical signal at the RS-232 receive data interface; and
- B) Repeat the optical signal at a launch power of at least -15 dBm via the optical transmitter opposite the receive side (i.e. if received upstream then transmit downstream; if received downstream then repeat upstream) with delays not to exceed 1 microsecond.

The data rate of the OTR/RP link shall be automatically adaptable to the attached RS-232 electrical signal interface to a minimum of 50 kbps. Typical data rates to be utilized on the communications links are 1200, 2400, 4800, 9600, 19.2 and 38.4 kbps.

The optical repeating process shall not add signal distortion nor optical noise which would comprise the link performance to achieve a 10^{-9} bit error rate. To assure stability of the optical transmitter over environmental temperature range, the optical transmitter shall be a solid state laser diode; edge emitting transmitter devices shall not be utilized.

The master controller may be interconnected with an RS-232 OTR which is interconnected with an RS-232 OTR which is non-repeating, designated "OTR". The OTR/RP(s) provided shall be optically compatible with OTR(s) provided. Similarly, the electrical RS-232 interface shall also be compatible between any other OTR/RP(s) and OTR(s) provided. An OTR/RP shall be usable as a master controller interface to control the multi-dropped communications link with any upstream-terminated communications port.

2.3 Communication Performance -

All OTR/RP(s) shall have compatible communications specifications. When two (2) or more OTR/RP(s) are interconnected by a single-mode fiber optic cable conforming to the following specifications:

Type:	Single-Mode
Core Diameter:	8.3 \pm 0.5 micron
Mode Field:	
Depressed Clad	8.8 \pm 0.5 micron
Matched Clad	10.5 \pm 1 micron
Concentricity:	\leq 1.0 micron
Cladding Diameter:	125.0 \pm 2 microns
Coating Diameter:	250.0 \pm 15 microns
Operating Wavelength:	1300 nm
Link loss does not exceed:	17 dB

and, the link loss budget between any two (2) OTR/RP(s) does not exceed 15 dB when the two (2) communications devices:

- 1) Are operated within the environmental specifications stated herein;
- 2) Are operated within the power input variations specified herein;
- 3) Are electrically compliant with the RS-232 and data rate specifications stated herein; and
- 4) Are operated with error-free input data,

then, the receiving OTR/RP(s) shall provide electrical interface to all attached controllers with a bit error of no greater than 1 in 10^9 bits.

The OTR/RP shall be provided with an anti-streaming function which will inhibit the connected controller from transmitting if a selected transmit time is exceeded. Maximum transit time shall be selectable in binary increments of 4, 8, 16, 32, 64 or infinity (i.e. anti-streaming disabled) seconds. A dip switch shall select the anti-streaming time out. Factory setting of the anti-streaming time setting shall be 16 seconds. Should the maximum selected transmission time be exceeded, the anti-streaming logic shall detect a data transmission from the RS-232 port, inhibit the "Clear to Send" control signal, and block the transmission port. Once the anti-streaming logic has been activated, the "Clear to Send" control signal shall be inhibited and the transmitted data port blocked until a manual reset button located on the OTR/RP is depressed by maintenance personnel. Activation of the anti-streaming function shall not impact the repeating function of the OTR/RP.

2.4 Quality Assurance -

Each OTR/RP device shall be successfully pre-tested to a formal factory functional test procedure. Each OTR/RP shall have been tested for a time period and with appropriate environmental stress screening to eliminate infant mortality of electronic components and marginal mechanical connections of electrical devices supporting the required product reliability. Products which have not been previously field tested in a similar environment are unacceptable. The OTR/RP devices shall be manufactured and tested under Quality Assurance procedures as recommended by BELLCORE, Electronic Industries Association or compliant with International Standards Organization, ISO-9000 Quality Assurance Specification.

The OTR/RP shall have a Mean Time between Communication Failure of 43,800 hours when operated as a pair, to a 95% confidence level. The OTR/RP shall comply with FCC Class A requirements.

The following specifications apply to the OTR/RP to the extent specified herein. Where a conflict exists between referenced specifications and this specification, this specification shall have precedence. Unless otherwise noted, the latest issues of specifications shall apply.

Electronic Industries Association (EIA)

Specification Number	Title or Subject	Applicability
RS-232 C/D	Serial Data Transmission, Physical, Functional and Electric Specifications	OTR/RP shall accommodate interfaces

Institute of Electrical and Electronic Engineers

Specification Number	Title or Subject	Applicability
C2-1994	National Electrical Safety Code	Compliance as applicable to electronic communications devices for construction, power and safety
	National Electrical Safety Code	As applicable to electronic Communications devices

C62.36-1991	Test Methods for Surge Protectors Used in Low Voltage Data, Communications and Signaling Circuits	General Guideline
C62.41-1991	Recommended Practice on Surge Voltage Protection in Low Voltage AC Circuits	General Guideline
295-1969	Standard for Electronics Power Transformers	As applicable to power converter
1100-1992	Recommended Practice for Powering and Grounding Sensitive Electronics Equipment	General Guideline

Federal Communications Commission (FCC)

<u>Standard</u>	<u>Title or Subject</u>	<u>Applicability</u>
FCC Rules and Regulations for Class A Electronic Equipment; Vol. II, Part 18	Radio Frequency Interference and Electromagnetic Compatibility	As applicable to equipment class
FCC/OST MP-4	FCC Methods of Measuring Radio Noise Emissions from Computing Devices	General Guideline

Other Specifications

<u>Organization</u>	<u>Standard</u>	<u>Title or Subject</u>	<u>Applicability</u>
International Standards Organization (ISO)	ISO-9000	Quality Assurance	ISO-9000 or Bellcore TR-NWT-000874 applies. Intent is for product to be produced under a formal Quality Assurance Program.
Bellcore	TR-NWT-000874	Reliability and Quality General Requirements	ISO-9000 or this specification applies.

3.0 Construction Methods -

3.1 Mechanical Interface -

The OTR/RP shall be acceptable as a stand-alone unit mounted externally to the traffic controller or as an electronic device to be internally installed within the traffic controller. In either configuration, the OTR/RP design shall be modular with replaceable components which are easily accessible to maintenance personnel. The OTR/RP shall include visual signal indicators associated with communications between the OTR/RP units as listed below:

1. Transmit Data Optical Channel 1 (TD-1)
2. Receive Data Optical Channel 1 (RD-1)
3. Transmit Data Optical Channel 2 (TD-2)
4. Receive Data Optical Channel 2 (RD-2)
5. Request to Send (RTS)
6. Clear to Send (CTS)
7. Power On (PWR)
8. OTR/RP Fail - Anti-streaming Activated

An anti-streaming reset switch shall be provided to reset the OTR/RP, should the anti-streaming function be activated.

3.2 Physical -

All OTR/RPs shall, at the CONTRACTOR'S option, be either external or internal to the controller.

3.2.1 If External to the Traffic Controller -

OTR/RP(s) installed externally to the traffic controller shall be interchangeable between traffic controller cabinets. To this extent, the OTR/RP shall conform to standard mounting and interconnection provisions within the controller cabinet. The OTR/RP shall conform to the specified dimensions of 4.5" wide (114.3 mm) x 5.12" deep (130.1 mm) x 1.0" high (25.4 mm). A 10% variation is allowable; however, all OTR/RP(s) provided shall conform to the same dimensions to assure interchangeability. The mounting plate attached to the OTR/RP shall have mounting holes manufactured to the tolerances stated herein to assure interchangeability of units within controller cabinets.

Connectors shall be located on the OTR/RP for convenient cable attachments. Strain reliefs shall be included on all cables provided with the OTR/RP. Signal indicators shall be easily viewable when the OTR/RP is mounted in a controller cabinet.

Construction and materials selected for the OTR/RP shall prevent fungus growth and cathodic action. Flame retardant materials shall be utilized in the construction of OTR/RP electronics.

The OTR/RP shall be provided in an aluminum housing which has been treated to prevent corrosion. All connectors and replaceable components shall be marked or labeled with identification conforming to the supplied equipment documentation, including schematics and parts lists. The OTR/RP external markings shall include the product name, model number, part number, serial number, manufacturer's name, and manufacturer's address.

The OTR/RP shall be free of sharp corners. Power input requirements, both voltage and current, shall be marked on the OTR/RP case. All power interconnections shall be protected against inadvertent contact by maintenance personnel. Any safety handling related instructions will be plainly marked on the OTR/RP case. The OTR/RP shall be shipped from the factory with protective connector covers.

3.2.2 If Internal to the Traffic Controller -

An OTR/RP(s) circuit assembly to be internally installed within the traffic controller shall be interchangeable between traffic controllers. To this extent, the OTR/RP circuit assembly shall conform to the standard mounting and interconnection provisions within the controller chassis.

Connectors shall be located on the OTR/RP circuit assembly for convenient cable attachments. Strain reliefs shall be included on all cables provided with the OTR/RP. OTR/RP signal indicators shall be easily viewable when the traffic controller is mounted in a controller cabinet.

Construction and materials selected for the OTR/RP circuit assembly shall prevent fungus growth and cathodic action. Flame retardant materials shall be utilized in the construction of the OTR/RP circuit assembly.

The OTR/RP circuit assembly shall be marked or labeled to the extent possible with identification conforming to the supplied equipment documentation, including schematics and parts lists. The OTR/RP circuit assembly external markings shall include the product name, model number, part number, serial number, manufacturer's name, and manufacturer's address.

The OTR/RP circuit assembly shall be shipped from the factory with protective connector covers.

3.3 Environmental -

The OTR/RP shall conform to the performance specifications stated herein when operated in the following environment:

Temperature: -34°C to 70°C

Humidity: 0 to 98% RH with minimal condensation

No cooling air flow shall be required. The unit shall be sealed to the extent that it may be damaged by blowing sand and dust. Units shall be shipped with protective covers over all connectors.

4.0 Method of Measurement -

The OTR/RP shall be measured by the number of EACH installed in place as required on the PLANS, including all related hardware.

5.0 Basis of Payment -

Each type of OTR/RP, accepted and measured as stated herein, shall be paid for at the contract unit price bid for installing and/or furnishing:

**FURNISH AND INSTALL FIBER OPTIC MODEM – EACH
INSTALL FIBER OPTIC MODEM - EACH**

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work specified herein.

FIBER OPTIC TRAINING

1.0 General -

The CONTRACTOR shall provide both formal classroom and "in-field" operations and maintenance training for up to fifteen (15) designated CITY and/or SCDOT personnel on the fiber optic cable system and its components. All training shall be coordinated by the CONTRACTOR at a time mutually agreed upon by the RCE, the CITY, SCDOT, and the CONTRACTOR. The classroom training session shall be held at SCDOT offices in Columbia. The DEPARTMENT shall make available a conference room where the training will be held.

Classroom training shall be completed prior to the CONTRACTOR beginning installation of the fiber optic cable. Field training shall be held in conjunction with the actual construction of the signal system.

All training material generated for each course shall contain "hand-outs" for each attendee. These hand-outs shall serve not only as subject guidance, but as quick-reference material for future use by the students. All course material, in reproducible form, shall be delivered to the ENGINEER immediately following course completion. If available, the CONTRACTOR shall provide video tapes of the training program.

The schedule for such training shall be submitted for approval by the RCE at least two (2) weeks prior to the proposed starting date.

2.0 Classroom Training -

Personnel shall be trained to install, splice, and test fiber optic cable. This training shall be a minimum of 32 hours. The 32 hours of fiber optic training shall be a four (4) day course taught by personnel from the manufacturer of the fiber optic cable for the project. Topics in the course shall include: safety, theory, fiber types, cable placement techniques, fiber optic sheath removal, hardware types, fault location with an optical time domain reflectometer (OTDR), splicing and termination methods and applications, theory and principles of splicing, fusion splicing, mechanical splicing, cable preparation procedures for installing optical connectors, installing ST connectors, mocking up a typical traffic control system, cable system testing and documentation, attenuation test procedures, and overall cable system maintenance. This course shall include lectures, demonstrations and hands-on experience with the equipment. Students shall be given hand-outs to use as guides for field applications.

In addition to the above training, the CONTRACTOR shall assist the CITY and SCDOT in developing regular preventive maintenance plans for the fiber optic communication plant (which includes the fiber optic cable, the fiber interconnect centers and the fiber optic modems).

3.0 Field Training -

Field training shall be provided to the CITY and SCDOT personnel assigned to the project. This training shall consist of the following as a minimum: eight (8) hours of fiber optic communications plant trouble shooting including fault location using an optical power meter/light source and using an Optical Time Domain Reflectometer (OTDR) cable tester, four (4) hours of field splicing (which shall include re-enterable rotary mechanical splicing and fusion splicing techniques), and four (4) hours of training on the installation, maintenance, and replacement of fiber interconnect centers and fiber optic modems. This training should be done in conjunction with the actual installation of the system, and should be both observatory and "hands-on" (whenever possible).

4.0 Course Outlines and Workbooks -

For both types of training, the CONTRACTOR shall submit to the RCE for approval four (4) copies of all proposed training material, which shall include course curriculums, draft manuals, and resumes of instructors. Such submittal shall be made at least four (4) weeks prior to the scheduled starting date. The RCE shall notify the CONTRACTOR within five (5) days if the proposed training material is acceptable. For the classroom training, the CONTRACTOR shall also provide for each participant a course workbook, which shall be provided in loose-leaf format in a three (3) ring binder.

5.0 Basis of Payment -

TRAINING - LUMP SUM

FURNISH FIBER OPTIC TEST EQUIPMENT**1.0 Description -**

The CONTRACTOR shall furnish to SCDOT the following test equipment for the Department's use in maintaining the fiber optic cable plant:

Optical Power Meter
Optical Light Source
Emergency Restoration Tool Kit

The equipment furnished by the CONTRACTOR shall be new and in the manufacturer's packaging when given to SCDOT. The CONTRACTOR shall note that sections of the special provisions for testing of the fiber optic network state that an Optical Time Domain Reflectometer (OTDR) shall be used for testing purposes. The OTDR used for testing purposes shall be furnished by the CONTRACTOR.

2.0 Equipment Specifications -**2.1 Optical Power Meter -**

The CONTRACTOR shall furnish a hand-held optical power meter. The power meter shall test 850, 1300, and 1500 nm wavelengths. It shall measure optical power through fibers, check end electronics and power loss through the fiber. The meter shall have a rechargeable NI-CAD battery, AC adapter/charger, a backlit LCD display, be auto ranging and provide measurements in dBm and watts. The meter shall be capable of being used continuously for nine (9) hours without recharging and shall be furnished with an instruction manual. The meter shall have the capability of accepting interchangeable connector adapters and shall be furnished with a type ST compatible adapter. The meter shall also be furnished with an ST compatible bare fiber adapter. The optical power meter shall be from the same manufacturer as the optical light source. The meter shall be warranted by the manufacturer for at least one (1) year. The meter shall be a Siecor Model OM-100F or approved equivalent.

2.2 Optical Light Source -

The CONTRACTOR shall furnish a hand-held laser optical light source. The light source shall have a dual laser operating at 1310 and 1550 nm. The light source shall include a low-battery indicator, contain a built-in rechargeable NI-CAD battery and be furnished with an AC adapter/charger.

The optical light source shall be furnished with an ST compatible connector and shall be from the same manufacturer as the optical power meter. The meter shall be warranted by the manufacturer for at least one (1) year. The meter shall be a Siecor Model OS-100 or approved equivalent.

2.3 Transit Case -

The CONTRACTOR shall furnish a transit case for the storage and transport of the optical meter and optical light source. The transit case shall be approximately 14.0" (L) x 11.0" (W) x 6" (D) and shall be water, crush and dust resistant. The case shall be lined with shock absorbing foam that contains dedicated areas to securely store the power meter and light source. The case shall also include storage area for the battery chargers, a jumper box, and connector adapter box.

2.4 Emergency Restoration Kit -

The CONTRACTOR shall furnish an emergency restoration tool kit that contains all the necessary implements for the recovery of the single-mode fiber optic system. The kit shall contain as a minimum the following components.

- (1) Fiber Cleaner (score and snap)
- (1) Sheath Removal Tool
- (1) Buffer tube stripping tool
- (1) Crimping Pliers
- (1) Cam Splice Assembly Manual
- (1) Fiber Stripper Procedure
- (6) Cam Splice Assembly Fixture
- (6) Cam Splice No-Adhesive Mechanical Splices

The emergency restoration kit shall be a Siecor Model TKT-009-01 or approved equivalent.

3.0 Method of Payment -

The item "Furnish Fiber Optic Test Equipment" shall not be measured but will be paid as a lump sum item covering all the equipment specified.

4.0 Basis of Payment -

The item "Furnish Fiber Optic Test Equipment" shall be paid for at the contract price bid for

FURNISH FIBER OPTIC TEST EQUIPMENT – LUMP SUM

which shall be full compensation for all the test equipment and for delivery of the equipment to the SCDOT district offices in PROJECT DISTRICT.

FIBER OPTIC COMMUNICATION PLANT - TESTING

1.0 Description - The CONTRACTOR shall test the fiber optic cable before and after installation in accordance with the procedures in this project's special provisions. The results of the tests shall be provided to the Department's project RCE.

2.0 Fiber Optic Cable Tests -

2.1 Continuity -

Prior to the installation of any fiber optic cable, the CONTRACTOR shall test the continuity of each fiber using an Optical Time Domain Reflectometer (OTDR). The test shall be conducted while the fiber is still on the reel and the test results shall be provided to the RCE.

2.2 Splice Loss -

After the installation of the fiber optic cable, the CONTRACTOR shall test the dB loss for every splice of the fiber optic cable in accordance with procedures established in the OTDR operator's manual. The testing may be done in conjunction with the splicing of the cable. Any splice that has a splice loss >0.09 dB shall be re-spliced.

The CONTRACTOR shall provide hardcopy test results to the RCE that identify the location of the splice (Intersection name, splice tray #), the fiber (by buffer tube and fiber color), and the splice loss in dB.

2.3 Connector/End Splice Testing -

The CONTRACTOR shall test each connector/end splice loss in one (1) direction using an OTDR in accordance with procedures established in the OTDR operator's manual. The average mated connector/end splice loss shall be <0.5 dB. Individual mated connector pair/end loss shall be <0.7 dB. Any connector/end splice with a loss greater than 0.7 dB shall be replaced, by the CONTRACTOR. Any replacement connectors/ends shall also be tested.

2.4 End-to-End Attenuation Testing -

The CONTRACTOR shall perform end-to-end testing of each fiber between each place point at 1310 nm and 1550 nm in one (1) direction in accordance with EIA/TIA 526-7.

The CONTRACTOR shall provide hardcopy test results to the RCE that identify the two (2) ends of the test site, the fiber tested, the wavelength tested, the reference power output, and the system attenuation in dB.

The CONTRACTOR shall provide OTDR Signature traces of all fibers between all intersections for system documentation and restoration purposes.

3.0 No Direct Payment for Testing -

Testing of the fiber optic communications plan will not be measured for separate payment. The CONTRACTOR shall include the cost of the testing in the bid price for other communication related items.

FURNISH AND INSTALL SPREAD SPECTRUM RADIO ASSEMBLIES
(For Traffic Signal Interconnection)

DESCRIPTION - This work shall consist of installing and or furnishing all materials and all related wiring necessary to provide radio communication links between each subsystem master and each local subsystem controller in accordance with these specifications at locations shown in the PLANS.

1. MATERIALS -

1.1 Spread Spectrum Radio -

1.1.1 Description - Work under this item shall consist of furnishing and installing spread-spectrum radio assemblies, including all ancillary components, as hereinafter provided, and delivering the required number of spread-spectrum radio assemblies to the job site as shown on the PLANS.

1.1.2 Materials - Each spread-spectrum radio assembly shall be a Cylink model Airlink 64MP or approved equal, meeting or exceeding the following requirements:

- Must meet FCC Part 15.247 requirements
- Use Direct Sequence Spread-Spectrum Modulation
- Operating frequencies: 902 to 928 MHZ
- 1 milliwatt to 800 milliwatt output power, user selectable in not less than 8 steps
- 9 synthesized carriers allowing 5 non-overlapping channels, user selectable
- Selectable RTS-CTS delay (minimum 4, from 10 to 105 msec)
- LED indicator for sync
- RS-232 DB25 DTE data interface
- Burst Sync for hub and repeater use (BNC Connector)
- 'N' type female antenna connection
- Data rates of 1.2, 2.4, 4.8, 9.6, 19.2,56.0 and 64.0 kbps asynchronous; selectable
- DCE clock source
- Connector (or adapter) for connection to antenna drop cable
- Receive sensitivity of -95 dbm, or better
- Shielded from EMI and RFI interference
- Operable in point -to- multipoint mode; full-duplex
- Maximum bit error rate of 1 erroneous bit every 10⁶ bits, unfaded
- Maximum dimensions of 3 inches (H) x 9 inches (W) x 12 inches (L) shelf mount
- Transmission range of 5 miles
- Line attack time: 18 milliseconds
- Power requirement-120 VAC, 60, Hz. The radio shall be plugged into a NEMA 5-15R receptacle located in the processor cabinet. A 3-foot power cord with appropriate 3-prong plug shall be provided.
- Environmental: Temperature range of -34°C to 74°C, 0% to 95% relative humidity, non condensing.

1.2 Antenna Feedline Cable -

1.2.1 Description - Work under this item shall consist of furnishing and installing all cable and connectors required to connect the spread-spectrum radio antenna drop cables to the spread-spectrum radio lightning protectors as specified herein, as shown on the PLANS and as hereinafter provided.

1.2.2 Materials - The antenna feedline cable shall be Andrew type LDF5-50A or approved equal, and shall meet or exceed the following requirements:

Impedance: 50 Ohm
 Attenuation: 1.3b/100 ft @ 900 MHZ
 Size: 7/8" diameter
 Jacket Material: Black Polyethylene
 Type: Coaxial with Foam Dielectric
 Minimum Bending Radius: 10 in.
 Connectors: Type N male (lighting protector end), type N female (antenna end)

1.3 Furnish and Install Antenna Drop Cables -

1.3.1 Description - Work under this item shall consist of furnishing and installing all cable and connectors required to connect the spread-spectrum radio to the lightning protectors and from the antennas to the antenna feedline cables as specified herein, as shown on the PLANS and as hereinafter provided.

1.3.2 Materials - Antenna drop cables for connections from the antennas to the feedline and from the lightning protectors to each radio and antenna assembly, drop cables and connectors shall be furnished, installed, and tested. The drop cables shall be 1/4" super-flexible foam dielectric hard-line, type 9913 or approved equal, and shall be equipped with factory installed connectors as a complete unit. The cable shall meet or exceed the following specifications:

- Impedance: 50 Ohm
- Attenuation: 4.2 db/100 ft @ 900 MH
- Core Insulation Semi-solid polyethylene foam
- Outer Diameter: 0.405 inch
- Shield: 100% coverage, 90% tinned copper
- Outer Jacket: Black PVC, UV protected
- Length: As shown on PLANS
- Connectors: N-male

1.4 Lightning Protectors -

1.4.1 Description - Work under this item shall consist of furnishing and installing all lightning protectors as specified herein, as shown on the PLANS and as hereinafter provided.

1.4.2 Materials - A lightning surge protector shall be furnished and installed between the antenna feedlines and the radio drop cables. The protector shall be properly grounded according to the manufacturer's recommendations. The protector shall be a PolyPhaser model IS-GF50LN or approved equal, meeting or exceeding the following requirements:

- Frequency Range: DC-1.5GHZ
- VSWR: 1.1:1 Max. to 1000 MHZ
- Power Capacity: 50 Watts @ 900 MHZ
- Insertion Loss: Less than .1 Db
- Surge Rating: 50,000 Amps max at 8x12 uSec 500 Joules
- Breakdown Voltage 2000V at 5KV/uSec
- DC Breakdown Voltage 600 VDC slow rising
- Impulse Life 10x1000 uSec 500 amps
- Insulation Resistance 100 megohms at 100VDC
- Turn On: 90V +/- 20%
- Turn On Time: 4ns for 2kv/ns
- Connectors: Female 'N' Type

1.5 Omnidirectional Antennas -

1.5.1 Description - Omnidirectional antennas shall be furnished and installed at certain hub sites as shown on the PLANS. The CONTRACTOR shall refer to the PLANS for installation details.

1.5.2 Materials - The antennas shall be **Antenna Specialist ASPG973** or approved equal, meeting or exceeding the following specifications:

- Construction: Fiberglass Construction
- Gain: 6 db over dipole, omnidirectional pattern
- Wind Rating: 115 mph
- Frequencies of Operation: 902-928 MHZ

- Polarization: Vertical
- Mounting: All hardware required for mounting on 2" OD or less pipe
- Grounding System: Direct DC
- Impedance: 50 ohms nominal
- Connector: 'N' type female connector

1.6 Directional Antennas.

1.6.1 Description - Directional antennas shall be furnished and installed at each repeater and slave site, and at certain hub sites as shown in the PLANS. The CONTRACTOR shall use the plan details for installation practices.

1.6.2 Materials - The slave and repeater antennas shall be **Cylink L-band 12 db Yagis** or approved equal, meeting or exceeding the following specifications:

- Type: 9 elements, Directional Yagi type, including driven element
- Gain: 6 db over dipole
- Frequency Range: 902-928 MHZ
- Polarization: Mountable for horizontal or vertical polarization
- Impedance: 50 ohms nominal
- Matching Network: Gamma clamp and assembly for connecting cable
- Hardware: All hardware required for mounting on a mast bracket as shown on PLANS
- Connector: 'N' type female
- Wind Speed: 125 MPH

1.7 Multipoint Device Interfaces -

1.7.1 Description - Work under this item shall consist of furnishing and installing multipoint device interfaces as hereinafter provided, and delivering the required number of units to the job site as shown on the PLANS.

1.7.2 Materials - The multipoint device interface units shall allow multiple RS-232 devices to share a common data communications interface such as a type 170 controller or spread-spectrum radio. The multipoint device shall meet or exceed the following specifications:

- Master Ports: 1
- Slave Ports: 2
- Slave Contention Control: RTS
- Interface: RS-232 DB25, 300 bps-19200 kbps, asynchronous
- Interface Lines: Data, RTS, CTS, CD
- Power: Passive or line powered

2. CONSTRUCTION METHODS -

2.1 The CONTRACTOR shall install the spread-spectrum radios and lightning surge protectors in the processor assembly cabinets at the locations shown on the PLANS and as shown on the typical installation details. The protector shall be electrically bonded to the cabinet grounding system, including the ground rods, using a # 8 AWG stranded copper ground wire. The CONTRACTOR shall install the antenna drop cable between the spread-spectrum radio and surge protector.

The CONTRACTOR shall connect the antenna drop cable to the antenna. The connection shall be fully sealed with a waterproof antenna sealant type compound.

Antenna feedline cables shall be routed and connected in a neatly arranged manner. The antenna cables shall be terminated with a male 'N' type connector at the lightning protector, and a female 'N' connector at the antenna drop cable end.

The antenna feedline cables shall be connected to the antenna drop cable as shown on the PLANS, and routed to reduce strain. All connections shall be fully sealed with a waterproof antenna sealant tap compound.

The opposite end of the cable shall be connected to a lightning surge protector located in the controller cabinet.

The cable shall be installed in the pole and running from the base of the pole to the cabinet in conduit as shown in the PLANS.

The cable shall be supported inside steel signal poles by attachment to the J-hook, and inside concrete strain poles by attachment to the embedded reinforcing bar, using an approved cable clamping device.

The antenna feedline cables and drop cables shall not contain any splices (with the exception of where they interconnect to each other).

The antenna cable shield shall be made electrically and mechanically secure to form a direct DC ground path. The antenna shield shall remain at the same electrical potential as the antenna mounting mast.

2.2 The CONTRACTOR shall perform continuity tests on all antenna cables between the antenna and the processor cabinet following installation of the cable, but prior to making any connections.

Continuity tests shall be performed using a volt-ohm-millimeter and a Metallic time Domain Reflectometer (MTDR). The antenna cable shall not exhibit any discontinuities such as opens, shorts, crimps, or defects.

2.3 The CONTRACTOR shall install the antennas as shown on poles by means of a mast bracket as shown on the PLANS. The mast bracket shall be of a diameter and construction as recommended by the antenna manufacturer, and approved by the engineer. The mast bracket shall be electrical and physically bonded to the pole. The bracket shall be properly grounded to the pole's grounding system.

Antennas at slave and repeater sites shall be oriented such that the maximum signal is obtained from the corresponding master or slave spread-spectrum radio location as shown on the PLANS. The polarity of all antennas shall be vertical. Adjustment of antenna orientation shall be the responsibility of the CONTRACTOR during the testing and integration period.

2.4 Testing - Following installation of the spread-spectrum radio assemblies, installation of the antenna cable and all connections, and the successful testing of the antenna cable, the CONTRACTOR shall perform the following tests:

2.4.1 A V.S.W.R. test shall be conducted, from the connection at the radio, with a fully configured antenna system (antenna, cable, and all connections). The V. S. W. R. shall not exceed 1.5:1 at 900 MHZ.

2.4.2 Each Spread-Spectrum Radio Assembly, including antennas, cables, and connectors, shall be tested with a bit error rate test unit (at 1200 bps) from the radio location to the associated master spread-spectrum radio location. Each channel shall be tested for 4 hours at a 2048 bit pattern. A hard copy output of results of each test shall be provided to the engineer by the CONTRACTOR. The maximum error rate shall be 1 erroneous bit every 10^6 bits.

2.5 After the spread-spectrum assemblies have been tested as specified about and placed in operation, the CONTRACTOR shall demonstrate that the assemblies operate as specified herein. Each spread-spectrum assembly--consisting of radios, cabling, and antennas--shall be tested for proper operation

for 30 consecutive days. The spread-spectrum radio test shall run concurrently for all slave and master spread-spectrum radio assemblies on the same channel. The spread-spectrum radio tests shall run concurrently with the 30-day test periods for the corresponding processor assemblies.

During the testing period, all CONTRACTOR-provided equipment at the assembly location shall operate without failures of any type. If any component malfunctions or fails to provide the capabilities specified herein, including a 95% level of accurate transmission during the 30-day test period, the CONTRACTOR shall replace or repair the defective equipment within 48 hours or notification by the engineer. Cost of correcting component malfunctions, shall be borne by the CONTRACTOR.

After the component malfunction has been corrected to the satisfaction of the engineer, a new 30-day test period shall be started. The 30-day test applies only to CONTRACTOR-furnished hardware. In the event of a failure of hardware furnished by others that prevents the 30-day test from continuing, the 30-day spread-spectrum test will be suspended until the other hardware failures are corrected, at which time the spread-spectrum test will resume.

2.6 The CONTRACTOR shall install the multipoint device interface units (shelf-mount) in the processor assembly cabinets at the locations shown in the PLANS.

2.7 The CONTRACTOR shall furnish and install all interconnecting cabling and connectors between the multipoint device interface units and the processors (170 controllers), spread-spectrum radios as required to make a complete and operational installation.

2.8 After the multipoint device interface units have been placed in operation, the CONTRACTOR shall demonstrate that the units and interconnecting cabling operate as specified herein. Each multipoint device interface unit shall be tested for proper operation for 30 consecutive days. The multipoint device interface test will be conducted concurrently with the spread-spectrum 30-day tests.

During the testing period, the multipoint device and cabling and connectors shall operate without failures of any type. If any component malfunctions or fails to provide the capabilities specified herein, during the 30-day test period, the CONTRACTOR shall replace or repair the defective equipment within 49 hours or notification by the engineer. Cost of correcting component malfunctions shall be borne by the CONTRACTOR.

After the component malfunction has been corrected to the satisfaction of the engineer, a new 30-day test period shall be started. The 30-day test applies on to CONTRACTOR-furnished hardware. In the event of a failure of hardware furnished by others that prevents the 30-day test from continuing, the 30-day test will be suspended until the other hardware failures are corrected, at which time the test will resume.

3. **ASSEMBLIES** - The PLANS indicate the location and configuration of radio equipment by one of three types of assemblies defined as follows:

3.1 Radio Hub Assembly - Shall consist of the following items described above any incidental hardware necessary to provide proper operation.

- Spread Spectrum Radio
- Antenna Feedline Cable
- Antenna Drop Cables (2)
- Lightning Protector
- Omnidirectional Hub Antenna
- Multipoint Device Interface

3.2 Radio Slave Assembly - Shall consist of the following items described above and any incidental hardware necessary to provide proper operation.

- Spread Spectrum Radio
- Antenna Feedline Cable
- Antenna Drop Cables (2)

- Lightning Protector
- Directional Yagi Antenna

3.3 Radio Repeater Assembly - Shall consist of the following items described above and any incidental hardware necessary to provide proper operation:

- Spread Spectrum Radios (2)
- Antenna Feedline Cables (2)
- Antenna Drop Cables (4)
- Lightning Protectors (2)
- Directional Yagi Antennas (2)
- Multipoint Device Interface

4. **METHOD OF MEASUREMENT** - Radio communications assemblies furnished and installed, will be measured by -EACH- type specified, and shall include all miscellaneous hardware, wiring and electrical connections necessary to provide complete and fully operational installations.

5. **BASIS OF PAYMENT** – Installing and/or furnishing radio communications assemblies, accepted and measured as described above, will be paid at the contract unit price bid for:

FURNISH AND INSTALL SPREADSPECTRUM RAD. HUB LOCAL- EA
 FURNISH AND INSTALL SPREADSPECTRUM RAD. HUB MASTER-EA
 FURNISH AND INSTALL SPREADSPECTRUM RAD. REPEATER- EA

INSTALL SPREADSPECTRUM RAD. HUB LOCAL- EA
 INSTALL SPREADSPECTRUM RAD. HUB MASTER-EA
 INSTALL SPREADSPECTRUM RAD. REPEATER- EA

This shall be full compensation for installing and/or furnishing radios, antennas, cables, switches, and all materials, equipment, labor, and incidentals to complete the work as specified.

FURNISH AND INSTALL DETECTOR LOOPS

DESCRIPTION - This work consists of furnishing and installing Detector Loops within and alongside the roadway, at the locations shown on the Plans, and in accordance with these Specifications. A Detector Loop installation shall consist of: installing the required conduit runs; making the pavement saw cut; placing the required number of turns of loop wire in the saw cut; creating a twisted pigtail; splicing the pigtail to the shielded, twisted pair lead-in cable; connecting the lead-in cable to the back-panel terminals at the controller cabinet; verifying proper detection of traffic; and sealing the saw cut. Several items used to create a complete detector installation are specified elsewhere. They are: FURNISH AND INSTALL ELECTRICAL CONDUIT; and FURNISH AND INSTALL SPLICE BOXES/ JUNCTION BOXES. The "junction point" referred to in the specifications below, is defined to be a splice box, or a conduit junction box as specified on the Plans.

1. MATERIALS -

Materials used in the fabrication of a Detector Loop shall meet the Specifications below:

1.1 Loop Wire -

Shall be splice-free lengths of: No. 14 AWG, 19 Strands, single-conductor bare copper wire. The conductor insulation (**BLACK**) shall be high density polyethylene and shall be both ultraviolet and weather resistant. The wall thickness shall be 0.030 in. minimum point thickness. Cable shall be manufactured in accordance with the requirements of Underwriter's Laboratories, Federal specifications, and the National Electric Code.

1.2 Lead-in Cable -

SEE 'FURNISH AND INSTALL ELECTRICAL CABLE'

1.3 Sealant -

The loop sealant used to fill the saw cuts and other gaps, shall be of a type intended for traffic loop embedding. The cured sealant shall be semi-flexible, and be capable of adhering securely to concrete, asphalt, wood, metal, etc. It shall be unaffected by freeze-thaw cycling, salts, gasoline, oil, sewerage and corrosive chemicals. It shall be proportioned and mixed per the manufacturer's specifications. Acceptable suppliers are:

3-M Detector Loop Sealant;
Preco Gold-Label Flex;
CraftCo MSI Hot Flow;
Bondo P-6061;
Pro-Seal 6006 or Pro-Seal 6006EX;
(--OR APPROVED EQUAL--)

1.4 Waterproofing Splice Materials -

The splice at the "junction point", shall be made waterproof using the materials listed below:

1.4.1 Cable Splice Kit -

Commercially available, Low-Voltage, water-proof Splice-kit; to be Plymouth "PLYFLEX"; or 3M "SCOTCH-LOK", Unipak #3570, Resin 400, (or approved equal). To be installed per manufacturers instructions.

1.4.2 Vinyl plastic electrical tape (use where required)- Cold and weather resistant, 19 mm (3/4 inch) wide, 1.8 mm (7 mil) thickness, (Scotch 33+ or approved equal).

1.4.3 Liquid electrical coating (use where required)-

Fast-drying sealant compatible with vinyl tape, brush-applied (3M, Scotchkote or approved equal).

1.4.4 Underwater Splicing Kit -

Where shown on the Plans, in very wet areas an Underwater Splice Kit may be required at the "junction point". This splicing kit shall consist of a two-piece mold-body, with pourable resin sealing compound, funnels, and end sealing strips (3M, Scotchcast 82-A1 or approved equal).

1.5 Wire Crimps -

The PREFERRED splicing method at the "junction point", shall use a commercial/industrial grade, copper-alloy CRIMP-ON, with one end closed, of a size proper for the gauge of wires to be spliced, and the number of conductors. It shall be installed with the proper CALIBRATED, RATCHET-TYPE, CRIMPING TOOL, intended for the purpose (NOT regular pliers). (Note: wire-nuts are not acceptable.)

1.6 Solder -

The alternate method of splicing at the "junction point" is to use SOLDER, which shall be electronic-grade, rosin-core, 60 lead/40 tin. Acid-core solder is not acceptable, nor are acid-type soldering pastes.

1.7 Splice Box and Junction Box -

Specified elsewhere as separate items. The references to "junction point" in this specification will usually imply such a splice box, or conduit junction box. However, some Plans may require direct installation to a signal pole base, where the splice between the loop wire and the lead-in cable will be made in the hollow pole.

1.8 Electrical Conduit -

Specified elsewhere as a separate item.

2. CERTIFICATION -

2.1 The CONTRACTOR SHALL PROVIDE details for the proposed loop sealant, loop wire, and lead-in wire.

NOTE: CATALOG CUTS ARE REQUIRED.

SAMPLE REQUIRED.

3. CONSTRUCTION METHODS -

3.1 Saw Cuts -

3.1.1 The LOCATION and SIZE of each loop shall conform to the Plans and to the Standards. In general, the front of each loop shall be located 0.3 to 0.45 metres (12 to 18 inches) behind the Stop Line, or as shown on the Plans.

3.1.2 Loops shall be centered in the traffic lane to be detected or as shown on the Plans.

3.1.3 Prior to cutting, the intended saw cut shall be carefully (using paint or chalk) marked on the pavement and approved by the Engineer.

3.1.4 The Contractor shall slot the roadway using a diamond or abrasive rotary power-saw with a blade approximately 9.5 MM (3/8 INCH) IN WIDTH. The saw shall a power-driven walk-along model, not a hand-tool.

3.1.5 The MINIMUM DEPTH of each Saw cut shall be:
50 MM (2 INCHES) DEEP in CONCRETE; and
65 MM (2-1/2 INCHES) DEEP in BITUMINOUS pavement.

3.1.6 The corner treatment of the saw cut shall prevent sharp edges. Saw cuts shall be extended to provide full-depth. All corners, where loop wires turn, shall be diagonal cut.

3.1.7 Saw cuts shall be washed out, blown dry, and shall be free from dust, grit, oil and moisture before the placement of wire. Compressed air shall be used to blow dry.

3.1.8 Saw cutting of curb and gutter shall not be permitted. Rather, a 38 mm (1-1/2 inch) hole shall be drilled under the curb at a 45 angle.

3.1.9 Pavement seams or cracks should be avoided. However, when it is necessary to traverse a crack, a 50 mm (2 inch) diameter hole at least 76 mm (3 inches) deep should be drilled, and slack provided in the loop wire to allow for expansion and contraction.

3.1.10 Loop installation shall be staged so that each entire loop installation (from saw cut to sealing) is completed within the same working day with minimum blockage of traffic.

3.2 Loop Wire -

3.2.1 Each loop wire shall be continuous and splice-free. Further, any wire with cuts, breaks, or nicks in the insulation shall not be accepted. All loops shall be wired in one direction, this will be a counter-clock-wise direction.

3.2.2 Each loop shall have the number of Turns shown in the table below, or as shown on the Plans.

<u>SIZE</u>	<u>NUMBER OF TURNS</u>
1.8 x 1.8 m (6 x 6 ft)	4
1.8 x 3.0 m (6 x 10 ft)	4
1.8 x 4.6 m (6 x 15 ft)	3
1.8 x 6.0 m (6 x 20 ft)	3
1.8 x 9.2 m (6 x 30 ft)	3
1.8 x 12.2 m (6 x 40 ft)	2
1.8 x 15.2 m (6 x 50 ft)	2
3.0 x 6.0 m (10 x 20 ft)	3
3.0 x 9.2 m (10 x 30 ft)	3
3.0 x 12.2 m (10 x 40 ft)	2
OTHER SIZE'S	AS PER PLANS

3.2.3 Each Detector Loop shall be formed by installing in a separate saw cut, one (1) continuous length of single conductor wire, from the nearest approved "junction point", around the loop the specified number of turns, then back to the "junction point".

3.2.4 The "pigtail" from the corner of the loop, formed by the two ends of the loop wire, shall be twisted together with a pitch of 15 TURNS PER METRE (YARD), between the "junction point" and the loop itself.

3.2.5 The wire shall be pressed to the bottom of the saw cut slot. A roller or a blunt-stick (similar to a paint stirrer), shall be used to seat the loop wire at the bottom of the slot or channel. In no case shall a screw driver or similar sharp tool be used for this purpose.

3.2.6 The wire shall be laid in the slot so that there are no kinks or curls, and no straining or stretching of the insulation around the corner of the slot, or at the junction.

3.2.7 After placing the wire in the slot, it shall be rechecked for slack, raised portions, and tightness.

3.2.8 2.5 CM (1 INCH) LENGTHS of 13 mm (1/2 inch) closed-cell foam-plastic (BACKER-ROD) shall be used at 0.6 metre (2 foot) spacings, to hold the wire at the bottom of the slot.
DO NOT use backer-rod around the entire perimeter!

3.2.9 The loop wire pigtail should be enclosed in conduit from the roadway edge to the "junction point".

3.2.10 Each loop shall be TESTED BEFORE SEALING. the inductance shall be in the range of 50 to 2500 micro-Henrys. The insulation resistance measured to earth ground shall be greater than 100 megohms at 500 volts DC.

Note: MEGGER TEST and INDUCTANCE TEST REQUIRED before and after sealing. A written record of the test shall be submitted to the Engineer on an approved form.

3.3 Lead-In Cable -

3.3.1 The lead-in cable shall be continuous, splice-free, and free from cuts or nicks in the insulation.

3.3.2 At the specified "junction point", the twisted "pigtail" from the loop wire shall be spliced to the shielded, (twisted-pair) lead-in cable that runs from the "junction point" to the controller cabinet (terminal).

3.3.3 The "junction point" splice shall be electrically permanent and sealed waterproof. Forty (40) mm (1-1/2 inches) of insulation shall be removed from each wire. The splice shall be either crimped-on, -or-twisted and soldered. the entire splice shall then be sealed waterproof using a method described below. The Engineer must be present to witness these acts. Any splices made without the presence of the Engineer are unacceptable, and shall be re-spliced. The methods of waterproof sealing are:

A. Normal Splice -

Each individual splice (pair of twisted loop wires meeting pair of loop lead-in wires), shall be performed by using either crimp-on's, or a soldered joint. The junctions shall then be sealed in a low-voltage, waterproof splice kit. The splice kit shall be installed per the manufacturers instructions.

B. Underwater Splice -

Where required on the Plans an underwater splice kit shall be installed according to the manufacturers instructions.

3.3.4 Sufficient slack shall be left in both the lead-in cable and the loop wire, so that the splice may be moved 1.0 metre (3 feet) from the front of the "junction point". The slack shall be neatly coiled and nylon-tied after completion of the splice.

3.3.5 In the controller cabinet, the lead-in cable shall be uniquely identified by an insulated, preprinted-sleeve, slipped over the wire before attachment of a spade-lug connector. A spade-lug connector shall be crimped onto each loop lead-in wire.

3.3.6 In the controller cabinet, the ground (drain) wire from each lead-in cable shall not be connected. Rather it shall be cut-off at the cable sheath, and left floating.

3.3.7 Unless otherwise specified, the lead-in cable shall be enclosed in conduit from the "junction point" to the nearest signal pole, or directly to the controller if it is on the same corner. The cable shall then run: up inside a conduit or metal pole, across span wires, and then down inside a conduit or metal pole, to the controller.

3.4 Sealant -

3.4.1 The Department approved Loop Sealant shall be mixed and applied according to the manufacturer's directions.

3.4.2 The sealant shall not be poured into saw cuts during weather conditions of precipitation of any kind, or at temperatures below 10° C (50° F).

3.4.3 The saw cut and drilled holes shall be completely filled with sealant, allowing no bubbles below the surface and only a minimum spill-over along the joint. Duct-Seal shall be used to prevent sealant from flowing into conduit ends.

3.4.4 When the sealant hardens, there shall be neither a bulge or depression, but rather a smooth road surface. The sealant shall not be over-poured so there is a bulge or bump higher than the surrounding surface of the roadway. It shall be wiped smooth with a squeegee.

3.4.5 The Contractor should make sure that the sealant has hardened before allowing traffic to move over the area.

4. METHOD OF MEASUREMENT -

4.1 Detector loops shall be measured by LINEAR FEET (METRE) of: loop wire, lead-in cable, and saw cut as actually placed, including sealant, electrical connections, testing, and incidental hardware. Note that conduit and vehicle detector amplifiers are measured elsewhere as separate items.

5. BASIS OF PAYMENT -

5.1 Detector loops, measured as provided above, shall be paid for at the contract unit price bid for:

Loop Wire:

NO. 14 COPPER WIRE 1-CONDUCTOR, 19 STRANDS, BARE COPPER WIRE-- LINEAR FEET (METRE)

Loop Lead-in cable:

NO. 14 COPPER WIRE 4-CONDUCTOR GRAY -- LINEAR FEET (METRE)

NO. 14 COPPER WIRE 8-CONDUCTOR GRAY -- LINEAR FEET (METRE)

SAW CUT -- LINEAR FEET (METRE)

and such payment shall be full compensation for furnishing all materials, equipment, labor, and for all testing, details and incidentals necessary to provide proper vehicle detection, complete in place as specified.

LOOP DETECTOR INSPECTION REPORT

LOCATION:
DESCRIPTION:

DATE:
BY:

LOOP POSITION		BEFORE SEALING			AFTER SEALING		
APPROACH	LANE	f kHz	L μh	R MΩ	f kHz	L μh	R MΩ

COMMENTS

NOTE: L SHALL BE 50 -2500 μh; R SHALL BE >100 MΩ @ 500 VDC

SUBMITTED BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
IN SERVICE BY	DATE	TIME	CHECKED BY	DATE	TIME

FURNISH AND INSTALL ELECTRIC SERVICE

DESCRIPTION - This work consists of furnishing and installing complete Electrical Services to provide electric power to traffic signals, at locations shown on the Plans, and in accordance with Power Company procedures.

1. **GENERAL** -

1.1 Standards -

All work is to be in accordance with the signal Installation Details, the Standards, or the REQUIREMENTS OF THE LOCAL POWER COMPANY. All work shall be in accordance with the National Electric Code (NEC), and applicable local Codes.

1.2 Meeting -

The Resident Construction Engineer, the CONTRACTOR, and the Power Company Representative shall discuss the project at the "Pre-Construction Meeting", and arrange the schedule for power connection. Additional meetings will be held as necessary to satisfy all concerns about Electrical Service.

1.3 Representative -

The Power Company Representative for this project is:

For the name and address of the local utility company:

SC DOT Utility Engineer
Room 322
955 Park Street
Columbia, SC 29202
(803)-737-1293

1.4 Schedule -

The CONTRACTOR shall make all necessary arrangements with the Power Company to ensure having the needed power available at the TIME OF SIGNAL TURN-ON. Difficulties in securing the service of the Power Company are to be immediately reported to the Engineer.

1.5 Location -

The CONTRACTOR shall determine the exact location of the electric service. The nature of the service is shown on the Plans, but shall also be finalized as: 1) Overhead service drop to controller pole; 2) Overhead service drop to service pole, then underground to controller (isolated); or, 3) Underground Power Company feed, to service on the back of controller cabinet.

1.6 Meter -

The electric service will usually be METERED. The CONTRACTOR shall provide hardware accordingly.

2. **MATERIALS** -

The power connection shall be a SINGLE-PHASE, 120/240 VOLT, 3-WIRE, 60 Hertz alternating current supply.

2.1 Meter -

The CONTRACTOR shall furnish and install the METER BOX (PAN), and the HUB.

2.2 Disconnect Switch -

The disconnect switch shall be NEMA STANDARD TYPE 3R, weatherproof. It shall be CIRCUIT BREAKER TYPE, and have a tab for pad-locking the cover closed. It shall be of 3-WIRE DESIGN (2-circuit), with solid neutral. The CONTRACTOR shall twist a No. 6 AWG wire through the padlock tab, to prevent unauthorized entry (until the District installs their own padlock).

2.3 Rating -

To provide a maximum of future flexibility, and a minimum of voltage-drop to the lamps, the components of the electrical service shall have the ratings stated in the following table:

ITEM	USAGE	
	<u>FLASHING BEACONS</u>	<u>TRAFFIC SIGNAL</u>
<u>DISCONNECT BREAKER:</u>		
Box Rating: (for uniformity)	60 AMP	60 AMP
Circuit Breaker (one side)	20 AMP	50 AMP
<u>CABLE:</u>		
3-Wire (W, BL, RD), THHN/THWN	No.6 AWG	No.6 AWG
<u>CONDUIT:</u>		
PVC Schedule 80	25 mm (1 in.)	25 mm (1 in.)

2.4 Ground Rod -

One or more ground rods shall be installed --at the service pole; and where applicable, at the controller itself.

The ground rod shall be 16 mm by 2.4 metres (5/8 inch by 8 feet) (minimum), copper-clad, with brass or bronze ground rod clamp. **The controller ground rod shall be EXOTHERMICALLY WELDED.**

2.5 Ground Wire -

The grounding wire for the service shall be No. 6 AWG, Bare, solid or stranded copper wire. (Note that this is in addition to the solid grounding wire running down each wooden pole.)

2.6 Conduit -

Conduit and Fittings used for the Electric Service shall be PVC Schedule 80, 25 mm (1 inch) DIAMETER. It shall extend from the point of Power Company attachment, through the meter and disconnect assembly, to the controller cabinet. (See FURNISH AND INSTALL ELECTRICAL CONDUIT.)

2.7 Weatherhead -

A weatherhead mating to the above conduit shall be used with overhead service connections. Also used shall be a strain Clevis, to create a 200 mm (1 ft.) minimum drip loop.

2.8 Cable -

The electrical cable installed from the point of Power Company attachment to the Controller Cabinet, shall be: Type THHN/THWN, sized per above table, 3-WIRE, (White, Black, red) 600 Volt, Copper only, stranded, with cable lugs. At no place shall the service cable be in the same conduit as signal cables or loop lead-ins.

2.9 Hardware -

All hardware used shall be rustproof: steel parts shall be stainless steel or galvanized. STAINLESS STEEL BANDS shall be used for attachment to steel poles. The bands are to be spaced every 1.0 metre (3 ft.) maximum, and at the top and bottom of the pole. When specifically required by the Utility Company or on wood poles, Conduit Clamps/strap, fastened with galvanized screws, may be substituted for the bands.

3. **CONSTRUCTION METHODS** -

3.1 The Electrical Service shall be installed in accordance with all applicable Codes, Regulations, and the REQUIREMENTS OF THE POWER COMPANY, with the final location being determined in the field. Typical construction methods are shown on the Installation Details, and the Standards.

3.2 The CONTRACTOR shall obtain all ELECTRIC PERMITS required; and shall arrange for INSPECTION at completion.

4. EQUIPMENT POWER -**4.1 Normal -**

The Type 170 Power Supplies with additional cabinet surge protection, for equipment for this Contract, (while operating from a 115 VAC, \pm 10%, Sixty (60) Hertz, commercial grade, non-dedicated power service), shall be capable of providing the following:

4.1.1 Proper regulation for AC outputs, up to one-hundred and fifty (150%) percent of normal load.

4.1.2 Sufficient internal electronic noise and transient immunity, so that equipment fed by this service will not be effected by either noise or transients.

4.1.3 Equipment power supplies of sufficient design to prevent extraneous coupling of signals between equipment.

4.1.4 Complete internal surge protection (in addition to that of the Controller Cabinet).

4.2 Additional -

Where electronic problems can be traced to Radio Frequency Interference (RFI), as shown by an oscilloscope, then the CONTRACTOR shall provide additional isolation, filters, capacitors, etc. to eliminate the problem.

5. GROUND SYSTEM -

5.1 The resistivity of the electrical system EARTH GROUND shall be FIFTEEN (15) OHMS OR LESS, as measured with an appropriate instrument which was calibrated not more than sixty (60) days prior to the date of performing such tests. The poles, ground rods, ground wires, span wires, etc. forming the traffic signal, are intended to form a "GROUNDING ELECTRODE SYSTEM" as defined by Article 250 of the NATIONAL ELECTRIC CODE.

6. METHOD OF MEASUREMENT -

Complete Electric Services shall be measured by EACH service installed in place, as shown on the Plans. It shall include all necessary conduit (trenched and/or riser), cable, conduit fittings, hardware, ground rod, banding, clamps, lugs, and all other materials and equipment specified or directed by the Engineer or Power Company. (Usually, there shall be no additional measurement of electrical cable used; there shall be no additional measurement of conduit used.) When an "Isolated electric service" is required by the Plans, an item and quantity will have been provided for wooden pole, as required.

7. BASIS OF PAYMENT -

Complete Electric Services, inspected, accepted, and measured as above, shall be paid for at the Contract Unit bid for—

ELECTRIC SERVICE FOR TRAFFIC SIGNAL – EACH

which shall be full compensation for furnishing riser, meter, disconnect switch, and all materials, equipment, labor, and incidentals to complete the work as specified.

FURNISH AND INSTALL SPLICE BOXES / JUNCTION BOXES

DESCRIPTION - This work shall consist of furnishing and installing Splice Boxes or Junction Boxes at the locations shown on the Plans in accordance with these Specifications. The Splice Box shall consist of a Box and Cover, installed over aggregate. The Splice Box is intended for use as a signal cable electrical enclosure. The Junction Box is intended for use as a loop detector "junction point". Unless shown mounted on a pole, it shall be installed in the dirt, at the depth of the conduit run, and covered with earth.

1. **MATERIALS** -

Shall meet the following requirements:

1.1 Box and Cover -

1.1.1 The Splice Box shall consist of a Base having an open top (the Box), with a separate removable Cover. They shall be made from a lightweight, blended modern material, using fiberglass reinforcement, and shall be **NON-CONCRETE / NON-STEEL**. They shall be **GRAY IN COLOR**. Covers shall have the LEGEND "**TRAFFIC SIGNAL**". They shall use **HEX-HEAD** stainless steel bolts. The **PHYSICAL FEATURES AND THE NOMINAL SIZE AND DIMENSIONS** for the Box and Cover, are shown on the Standards or the Design Details, and are listed below--

	<u>WIDTH</u>	<u>LENGTH</u>	<u>DEPTH</u>
SPLICE BOX:	3m (13in)	.61m (24in)	46m (18in)
CUSTOM SPLICE BOX: (bridge deck use)	.3m (12in)	.3m (12in) cut to .15m (6in)	.3m (12in)

1.1.2 The above "Custom Splice Box For Bridge Deck Use" shows the manufactured size. The Contractor shall **CUSTOMIZE** the Box by using a masonry cut-off saw to manually cut it to a nominal depth of .15 metres (6 inches), to fit flush with the finished surface of the bridge side walk.

1.2 Design Load -

Boxes shall be designed to survive a tandem wheel load specified by **AASHTO H 20-44**, being 32,000 pounds (14,514.9 kg) per axle, or 16,000 pounds (7257.6 kg) per tandem wheel pair. This 16,000 pound (7257.6 kg) dead load shall be multiplied by 1.3 impact factor, to obtain the **DESIGN TEST LOAD OF 20,800 pounds** (9434.7 kg). Thus, boxes shall be designed and tested for the following test loads:

Cover- vertical load 20,800 pounds distributed over a 10in x 20in area (9434.7 kg over .254 x .508 m).
Box- vertical load 20,800 pounds distributed over a 5in x 20in area (9434.7 kg over .127 x .508 m). Box- lateral load of 600 pounds per square foot (28728 Pascals). The cover deflection shall be less than 0.5 inch (1.27 cm); and the box deflection less than 0.25 in/ft of length (.635 cm/.3 m).
 (Because of quoted references, english units are first.)

1.3 Western Underground Committee (WUC) -

Using the above specified loads, the Splice Box shall meet or exceed the WUC "Recommended Guide No. 3.6, Non-Concrete Enclosures". Structural Requirements shall include: testing for Vertical Load on Cover; Vertical Load on Box; Lateral Load on Box. Further they shall meet WUC recommendations for: Accelerated Service per ASTM D-756; Chemical Resistance per ASTM D-543; Simulated Sunlight Resistance per ASTM G-53; plus Water Absorption; and Flammability. Covers shall be skid-resistant, with a minimum coefficient of friction of 0.5.

1.4 Concrete -

Concrete for patching shall be DOT Class A, mixed and installed in accordance with Section 700 of the STANDARD SPECIFICATIONS.

1.5 Aggregate -

Crushed stone for the Splice Box shall be DOT Aggregate Numbers 5 or 57.

2. **CERTIFICATION** -

2.1 The CONTRACTOR SHALL FURNISH certification from the Manufacturer or Vendor that the above material specifications have been met, including written results for Western Underground Committee tests.

NOTE: CATALOG CUTS ARE REQUIRED.

2.2 The Contractor shall provide the Department with all guarantees offered by the Manufacturer.

3. **CONSTRUCTION METHODS** -

3.1 Construction -

3.1.1 The Splice Box shall be constructed as indicated in the Design Details or the Standards, at locations shown on the Plans.

3.1.2 The Splice Box shall be constructed such that when the Box and Cover are in place, they are flush with the adjacent pavement, ground, or sidewalk, as shown in the Design Details or the Standards. Patching Concrete shall be placed around any Box installed in pavement.

3.1.3 Boxes shall be placed at least 0.3 metres (1 ft) behind the curb-line or edge of roadway or as shown on the plans.

3.1.4 Placed Before Pouring. Where shown on the Plans, Custom Splice Boxes shall be placed in roadways or structures, prior to pouring the concrete. Typical usage would be in a bridge deck. The incoming conduit shall be firmly attached to the bottom reinforcement bar mat, or to the bottom wire-mat, using plastic tie-wraps every 0.6 metres (2 feet). CAUTION: THE BOTTOM OF THE SPLICE BOX AND THE CONDUIT ENDS ETC. SHALL BE COMPLETELY PLUGGED/BLOCKED/SEALED TO PREVENT CONCRETE PENETRATION. When used on a bridge, the Splice Boxes will be near the center line, and the conduit will terminate in Splice Boxes at each end.

3.2 Conduit -

3.2.1 See FURNISH AND INSTALL ELECTRICAL CONDUIT

3.2.2 Conduit shall enter the Box at the bottom and extend at least 5 cm (2 in) beyond the inside wall.

3.2.3 Conduit shall enter from the direction of the run unless otherwise permitted by the Engineer.

3.2.4 All metallic conduit ends within the Box shall have grounding bushings with plastic inserts; and shall be bonded with one another with #6 AWG bare copper ground wire. Plastic conduits shall have end bushings to prevent chaffing.

3.2.5 After the electrical cable is placed, the completed conduit ends shall be packed with "duct-seal" or other equivalent material to prevent water from entering the conduit. Spare conduit shall be capped.

4. **METHOD OF MEASUREMENT** -

Furnishing and installing Splice Boxes will be measured by EACH Box placed complete, including Box, Cover, aggregate, patching concrete, ground wire, ground bushings, sealing, and all miscellaneous hardware and incidentals required.

Furnishing and installing Junction Boxes will be measured incidental to the conduit to which it is used with.

5. BASIS OF PAYMENT -

Furnishing and installing Splice Boxes, accepted and measured as provided above, will be paid for at the contract unit price bid for:

Splice Box:

13"X24"X18"D (.33X.61X.46D M) ELECTRICAL FLUSH ENCLOSURE (STR.POLY.CONC)--EACH

Custom Splice Box for bridge deck use (cut to 6"D .15 m):

12"X12"X12"D (.3X.3X.3 M) ELECTRICAL FLUSH ENCLOSURE (STR.POLY.CONC)--EACH

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL CCA WOOD POLES

DESCRIPTION - This work consists of furnishing and installing CCA treated wood poles, of the types and sizes shown on the Plans, in accordance with these Specifications, and in close conformity with the lines shown on the Plans, or as established by the Engineer. Each wood pole installation shall include all related overhead and underground hardware, and back guy assemblies as provided elsewhere.

1. **MATERIALS** -

Materials used shall meet the following requirements:

1.1 Wood Pole -

1.1.1 Wood -

Each pole shall be Southern Yellow Pine, that is cut, stored, seasoned, and manufactured in accordance with specification ANSI 05, 1-19-79. Prohibited defects include: red heart, shakes in the tops of poles, short crooks, double-sweep, splits or through-checks, nails & spikes, and excessive knots. Scars shall not be deeper than 2.5 cm (1 inch), nor longer than one (1) metre (3 feet). Poles shall not have excessive butt-swell, nor more than one twist per pole length. Sweep in two planes is prohibited.

1.1.2 Straightness -

All poles shall be straight to the extent that a line drawn from the center of the butt end, to the center of the tip end shall lie within the middle two-thirds of the body of the pole at all points. Poles shall also be free from short crooks, in which the surface deviation from straightness in any 1.5 metres (5 feet) of length, exceeds 38 mm (1.5 inches) at any location, as determined by a straight edge.

1.1.3 Treatment -

Each pole shall be prepared and pressure-treated in accordance with American Wood Preservers Association (AWPA) Standards C1, C3, C4, and M1. Treatment shall be "SALT TREATED", CCA-CHROMATED COPPER ARSENATE, and shall conform to AWPA Standard P5. The retention of the treatment shall be tested in accordance with AWPA Standard M2. The minimum penetration shall be 7.6 cm (3 inches), or 90 percent of the sap-wood. The retention shall be at least 9.6 kgs per cubic metre (0.60 POUNDS PER CUBIC FOOT), as determined by AWPA Standards.

1.1.4 Size -

EACH POLE SHALL BE CLASS II. THE LENGTH SHALL BE EITHER: 10.7 METRE (35 FEET), 12.2 METRE (40 FEET) -or- (45 FEET)
or as stated on the Plans.

1.1.5 Brand -

Each pole shall have a "brand" 3.6 metres (12 feet) above the butt-end, showing the Manufacturer. Plant-location with month and year of treatment, "Southern Pine CCA 0.60 (9.8)", and the Pole Class and Length. A Metal Tag showing Pole Length and Class shall be fixed to the butt-end; and the Length and Class shall be stamped on the top-end.

1.1.6 Inspection -

Each pole shall have the "Brand Mark" of an inspection-company that has been approved by the Department.

1.2 Back-Guy Anchor -

Wood Poles for traffic signal usage, require the installation of one-or-more back-guy cable assemblies, as needed. (See FURNISH AND INSTALL BACK-GUY.) The installation shall be made in accordance with the Installation Details, or the Standards.

1.3 Ground Wire -

Each pole shall be grounded in accordance with the Installation Details or the Standards. A No. 6 AWG, SOLID, bare-copper ground wire (ASTM B2) shall run the length of wooden poles, and extend 15 cm (6 inches) above the top end.

1.4 Ground Rod -

The Ground Rod shall be copper-clad, conforming to EEI-TDJ-30, having a minimum size of 1.6 CM DIAMETER BY 2.4 METRES IN LENGTH (5/8 inch by (8 feet)). A ground rod clamp shall also be used (heavy duty bronze or brass).

2. CONSTRUCTION -

2.1 Location -

The general location of each pole is shown on the Plans. The Contractor shall determine the final location of the pole, which shall be approved by the Engineer. Consideration shall be given to the property lines, underground utilities, and overhead clearances (including the guy anchor assembly).

2.2 Hole -

A hole shall be drilled TWO METRES (6 feet) DEEP, or as shown on the Plans. The diameter shall be larger than the pole by approximately 10 cm (4 inches) all around. The hole shall be of uniform diameter, and cleanly augured.

2.3 Sidewalk -

When the pole is installed in a sidewalk, then the hole shall be cleanly cut 15 cm (6 inches) larger than the pole on all sides. After installation of the pole, and back filling the hole, then expansion joint material shall be placed around the pole, and tacked in place. Conduit running to the pole shall be installed at this time, in the cut. Concrete shall be poured around the pole to a depth of 10 cm (4 inches) and neatly troweled level. This work shall be considered incidental to pole installation, unless a pay item has been established for concrete patching or sidewalk.

2.4 Installation -

Poles shall be vertical, except at corners, where they shall be RAKED away from the strain, 5 to 10 cm (2 to 4 inches) per 3 metre (10 feet) length. Back guy assemblies shall be installed in line with the strain of each span wire. After installing, the hole shall be back-filled with clean earth or sand (no rocks or debris), placed in 30 cm (1 foot) layers; each layer moistened and compacted. Excess earth shall be removed from the site. (A 5 cm (2 inch) mound around the pole base is acceptable.)

2.5 Utility Poles -

Where poles are to be used for joint-use UTILITIES, they shall be installed in accordance with all local codes, and with the requirements of the Utility Company. Cross Arms shall be provided if required by the Utility Company.

2.6 Grounding -

Each pole shall have a No. 6 Bare SOLID copper ground wire running the entire length. The ground wire shall be securely attached and bonded while the wood pole is laying on the ground. It shall extend 15 cm (6 inches) above the top end, have a 60 cm (2 foot) coil (slack) at the top end, and extend down to the bottom, and have another 60 cm (2 foot) coil on the bottom end. The ground wire (and the coils) shall be attached using galvanized 30 mm (1-1/2 inch) wire staples, on 60 cm (2 foot) centers above 3 metres (14 feet), and on 30 cm (1 foot) centers below 3 metres (14 feet). (The spacing change will be at 2.4 metres (8 feet) above grade.)

2.7 Ground Rod -

One wood pole at each intersection shall have a GROUND ROD. Usually this would be the pole having the electrical service from the Power Company. The ground rod shall be driven vertically into the earth, until it extends about 5 cm (2 inches) above local grade. Then a separate No. 6 AWG bare, STRANDED copper wire shall be used to bond the electrical service and the overhead cable (and pole ground wire) system to the ground rod, using a grounding clamp.

2.8 Back Guying -

Each wood pole that is used to support signal span wires, shall be back guyed. Wood poles used to support messenger cables could require back guying, especially at turns. (See FURNISH AND INSTALL BACK GUY.) It is the responsibility of the Contractor to install sufficient numbers of back guy assemblies, to insure the stability of wood pole installations. This may include: double-guying; extra large anchors; or Re-guying Utility Company poles. A quantity for "Back Guy" has been established in the Bid or Proposal. The Contractor shall inform the Engineer when additional back guy assemblies are required. When the back guy is installed in a sidewalk, then the procedures of paragraph 2.3 above shall be followed.

3. ACCEPTANCE -

Acceptance of each wood pole shall include checking for the pressure-treatment inspection company Brand Mark, plus visual inspection by the Engineer. The visual inspection shall be made of the pole, overhead cables, grounding, and back guy assembly. The complete installation shall be structurally sound, and the final pole placement shall be vertical, or raked as specified. Poles NOT meeting this inspection, shall be replaced by the Contractor, without further cost to the project.

4. METHOD OF MEASUREMENT -

Furnishing and installing wood poles, will be measured by EACH, of the Size specified, erected in place as shown on the Plans, including grounding, and all miscellaneous hardware and related work activity as required.

5. BASIS OF PAYMENT -

Furnishing and installing wood poles, accepted, and measured as above, will be paid for at the contract unit price bid for:

35 /40/45 FOOT WOOD POLE, CLASS II -CCA TREATED -- EACH;

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL BACK-GUY

DESCRIPTION - This work consists of furnishing and installing Back-Guy cable assemblies to secure wood poles, at locations shown on the Plans, and in accordance with these Specifications, and the Installation Details and Standards.

RESPONSIBILITY - It is the responsibility of the CONTRACTOR to assure that the number and size of Back-Guy assemblies is fully sufficient to anchor every wood signal pole, corner messenger cable pole, and Utility Company pole (where required).

1. MATERIALS -

Materials used shall meet the following requirements:

1.1 Assembly -

From the top-down, a Back-Guy Assembly shall consist of: eye-type thru-bolt, guy-hook, strandvise (or 3-bolt clamp), jumper-bonding clamp, the steel cable (10 mm (3/8-inch) guy-cable stranded), another strandvise (or 3-bolt clamp), and a Screw-type guy anchor.

1.2 Rust Proof -

All parts shall be as shown on the Installation Details or the Standards. All hardware shall be hot-dip galvanized in accordance with ASTM Standard A-153.

1.3 Parts List -

Acceptable parts are listed below:

1.3.1 Guy Anchors - One piece screw type guy-anchors, shall conform to EEI-TD-2, 25 mm (1 in.) diameter, 2.4 METRES (8 FEET) LONG, thimble eye type. (Joslyn No. J-6550-WCA or approved equal)

1.3.2 Guy Guards shall conform to REA Item "AT" yellow plastic (PVC) sunlight resistant, 2.4 metres (8 ft.) long.

1.3.3 Spool Insulators shall conform to REA Item "CM".

1.3.4 Strain insulators shall conform to REA Item "W".

1.3.5 Machine Bolts shall conform to REA Item "C".

1.3.6 `J' hooks shall be Reliable No. 5552 (or approved equal).

1.3.7 Reliable Universal Strandvise (or approved equal) shall be used for guy and messenger cable deadends.

1.3.8 Thimbleye Bolts shall conform to EEI-TD-4.

1.3.9 Thimble Nuts shall conform to EEI-TDJ-5.

1.3.10 Washers shall conform to EEI-TDJ-10.

1.3.11 Angle Thimbleye shall conform to REA Item 5.

1.3.12 Cable- SEE FURNISH & INSTALL STEEL CABLE; using
the 10 MM (3/8 IN) DIAMETER CABLE SIZE.

1.3.13 Cable Clamps: 3-bolt clamps shall conform to EEI-TDJ-23, (100 mm (4 in.) and 150 mm (6 in.) sizes)

1.3.14 Clevises shall conform to EEI-TD-20.

1.3.15 Side-walk Bridge-over shall be a stress supporting spreader-type, bolting to the wood pole.

2. **CONSTRUCTION** -

2.1 A Back-Guy Assembly shall be installed: 1) Where shown on the plans; 2) In conjunction with installation of Steel Cable as span wire; 3) In conjunction with the installation of a wooden pole; 4) Where required by the Utility Company to "dress" pole to which signal equipment is attached; or, 5) At corner/turning wood poles that are used for messenger cable runs.

2.2 The installation of the wood pole, Back-Guy Assembly, and the span wire, shall have the construction staged for the safety of the motorist, pedestrian, and signal construction worker.

2.3 See FURNISH AND INSTALL WOOD POLE.

2.4 The span wire and Back-Guy Assembly shall be stretched, adjusted, and then RE-ADJUSTED to produce the specified amount of span wire sag, the proper signal head road-clearance, and still create a nearly vertical wood pole.

2.5 The CONTRACTOR shall assure that the Back-Guy Assembly is sufficiently strong to handle the pull of all span wires. This shall include consideration of the earth/soil type into which the ground anchor is buried. The CONTRACTOR shall furnish EXTRA LARGE ANCHORS and/or MULTIPLE-ANCHOR ASSEMBLIES if needed. Special anchors shall be used for solid rock.

2.6 Where a pedestrian sidewalk is adjacent to a wood pole, the CONTRACTOR shall furnish as an incidental item, a sidewalk "bridge-over" assembly.

2.7 The compass angle of the Back-Guy shall be reasonably IN LINE with the strain of the overhead cable: that is, in line with each span wire. Thus most signal poles should have two (2) Back-Guys, installed at right angles to each other. The use of a single diagonal Back-Guy is generally unacceptable.

2.8 The Back-Guy shall be installed (wherever possible) to provide as a minimum: rise=2 / run=1 (i.e. 2/1). For example, if the Back-Guy is attached at 8 metres (26 feet), the anchor should be at a minimum of 4 metres (13 feet) from the pole. This corresponds to an angle with the earth of about 60 degrees.

2.9 All work shall be performed within the public Right of Way, and particular care shall be taken to assure that the Back-Guy does not extend into private property.

2.10 The Back-Guy shall be installed where it will not interfere with traffic, giving particular attention to private driveways. Where damage is likely (say, edge of driveway). then a STEEL GUY GUARD shall be installed to protect the cable. When shown on the Plans, a CONCRETE TIRE/WHEEL STOP (curb) shall be placed at the base of the Back-Guy, anchored/pinned with 400 mm (2 ft.) pieces of reinforcement bar.

2.11 NO splices shall be allowed in the steel cable.

3. **INSPECTION** -

The Engineer shall inspect each installation of wood pole, span wire, signal heads, and Back-Guy, for proper clearance, dress, and tension. At the direction of the Engineer, the CONTRACTOR shall re-install or replace improper installations, without further compensation.

4. **METHOD OF MEASUREMENT** -

Furnishing and installing Back-Guy Assemblies, will be measured by EACH, erected in place in accordance with the Specifications and as shown on the Plans, including all miscellaneous hardware as required.

Additional Back-Guy Assemblies that are installed for reason of situations or conditions that arise during construction, will be paid, and shall be measured by EACH.

5. **BASIS OF PAYMENT** -

Furnishing and installing Back-Guy Assemblies, accepted, and measured as above, will be paid for at the contract unit price bid for:

3/8 INCH (10 MM) BACK-GUY FOR WOOD POLE – EACH

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL STEEL STRAIN POLE

DESCRIPTION - This item shall consist of furnishing and installing Traffic Signal Steel Strain Poles, of the sizes shown, for state supply.

Concrete footings with reinforcing steel, anchor bolts, ground rods, conduit elbows, and miscellaneous hardware shall be installed with each pole as required.

1. DESIGN REQUIREMENTS FOR POLE -

1.1 General -

Each Strain Pole assembly shall consist of:

1. A steel Shaft,
2. A steel Anchor Base,
3. Four steel Anchor Bolts with eight nuts,
4. A removable top plate which will bolt to the shaft with a ¼" J-Bolt and attached to a ½" bar that is welded inside the shaft,
5. Four removable anchor bolt Covers,
6. Two adjustable heavy duty Pole Clamps, and
7. Miscellaneous hardware as specified.

1.2 Shaft -

1.2.1 The design of the shaft will be based on a minimum mill certified 55,000 yield strength steel. The following steel may be used in the fabrication of the shaft: ASTM A570-50, ASTM A572-50, ASTM A572-60, ASTM A607-50, ASTM A607-55, ASTM A607-60, ASTM A595-A or ASTM A595-B.

1.2.2 Only one (1) longitudinal weld, and no transverse welds, shall be permitted.

1.2.3 After being formed and welded, the Shaft shall then be longitudinally cold-rolled with sufficient pressure to flatten the weld. Break formed, (multi-sided) poles shall have a minimum of eight (8) sides and a guaranteed mill certified minimum yield of 55,000 PSI.

1.2.4 The Shaft shall have a uniform taper in diameter from base to top of .14 inches per foot. The minimum base diameter and length shall be as specified in the Dimensions Chart.

1.2.5 A reinforced hand hole, complete with frame and cover with a minimum size of 4" x 6 1/2", shall be welded into the Shaft approximately 12" above the base plate at 0 degrees. The frame shall be tapped with a 1/2" - 13 UNC for a grounding bolt. Stainless-steel hardware shall be supplied.

1.2.6 A J-hook wire support shall be welded inside near the top of the Shaft.

1.2.7 Round holes shall be provided in EVERY POLE as follows:

- 3", at 6" on-center below pole TOP; at 0 degrees (above hand hole).
- 3", at 6" on-center below pole TOP; at 270 degrees (orientate counter-clockwise).
- 3", at 1'-3 1/4" on-center above pole BOTTOM; at 90 degrees (orientate counter-clockwise).

1.2.8 The two (2) 3" upper holes are for installing weatherheads w/nipple and the lower 3" hole is to permit the installation of a pole mounted Controller Cabinet. A 3" threaded, half-blind coupling shall be **FACTORY WELDED**, to the pole surface and protrude ¼" in each hole. The entire pole coupling shall then be hot dipped galvanized.

1.3 Anchor Base and Flange Plates -

1.3.1 The Anchor Base and flange plates shall be made from ASTM A36 steel.

1.3.2 The Anchor Base shall be square (with rounded corners), and shall be of the size and thickness specified in the Dimensions Chart.

1.3.3 The Anchor Base shall be provided with four (4) holes to accept Anchor Bolts. The size of the holes and the bolt circle shall be as specified in the Dimensions Chart.

1.3.4 Tapped holes shall be provided for attaching removable Anchor Bolt covers, which shall be provided with stainless steel hex-head bolts.

1.3.5 The Anchor Base shall telescope the Shaft, and shall be secured to the Shaft by two fillet welds. One weld shall be on the inside of the base at the end of the Shaft, and the other shall be on the outside at the top of the base. The welded connection shall develop the full strength of the adjacent cross-section to resist bending action.

1.4 Anchor Bolts and Nuts -

1.4.1 Anchor Bolts shall be steel rods of ASTM A-36 M-55, modified to have a minimum yield point of 55,000 PSI.

1.4.2 Four (4) Anchor Bolts shall be supplied with each pole. The Anchor Bolt size shall be specified in the Dimensions Chart.

1.4.3 Each Anchor Bolt shall be threaded at the top for 10 inches, and shall have a 6 inch L-bend at the bottom, or a bearing plate as specified on larger pole sizes.

1.4.4 A total of eight nuts and eight flat washers shall be supplied and installed for each pole. Nuts shall be ASTM 563 Grade A. The two nuts per bolt may be either:

- a) two hex nuts (preferred), or
- b) one hex nut, and one square nut (acceptable). Note: All other bolts shall be ASTM A325 or A307, (threaded per UNC series).

1.5 Bolt Cover -

With each Pole there shall be supplied four (4) removable bolt covers capable of hiding the installed Anchor Bolts and the top nut. The covers shall have a clean-lined modern appearance. They shall attach to the pole with stainless-steel hex-head bolts. Acorn nuts shall also be acceptable.

1.6 Pole Cap or Top Plate -

1.6.1 Each pole shall be supplied with a Cap or top which shall be made from 7 GA. Galvanized steel or from cast aluminum, ASTM B-108; Alloy 356.OT6.

1.6.2 The Pole Cap shall be of a size greater than the pole top diameter and designed to prevent water from entering the top of the pole.

1.7 Pole Clamp -

With each Strain Pole there shall be supplied two adjustable Span Wire Clamps. Each span wire clamp shall be constructed of 1/4" x 3" steel minimum, complete with two 7/8" x 4" stud bolts including two lock washers and two hex nuts per stud bolt. Each span wire clamp shall also include a clevis complete with a 7/8" x 3" bolt with one lock washer and one hex nut.

1.8 Pole Plugs -

Plugs/Caps, either galvanized or stainless, shall be supplied for all holes in the steel pole. Plugs/Caps shall be installed in all un-used holes in the steel pole in a construction project.

1.9 Galvanizing -

The following shall be hot-dipped galvanized to ASTM A-123:

- 1) Shaft, Anchor Base, nuts, and hand hole frame and cover,
- 2) The top 12 inches of the Anchor Bolts, Pole Clamp, and
- 3) All other steel or iron parts.

1.10 Pole Labeling -

1.10.1 Every Pole shall be easily read and prominently labeled on the outside edge of the base plate. The method used shall be that the pole description is inscribed with "WELDING-BEAD", neatly hand-written, in 1-1/2 to 2 inch high letters. The legend used shall be one of the following:

- 13" X 26'
- 13" X 28'
- 13" X 32'

Note: Codes shall not be acceptable for pole size labeling. The labeling shall be applied prior to galvanizing.

1.10.2 Weather proof Color Coding shall be included on each pole to facilitate ease of selection and identification. The color coding shall be as follows:

- 13" x 26' Bright Green
- 13" x 28' Bright Red
- 13" x 32' Bright Yellow

1.11 DIMENSION CHART -

Strain Poles shall be supplied on a per EACH basis, with dimensions in accordance with the following chart:

<u>GALVANIZED STEEL SHAFT</u>			<u>GALVANIZED STEEL PLATE BASE</u>			<u>ANCHOR BOLTS</u>		
Type	Diam. at Base	Length	Mfr's Std. Gauge	Plate Size	Plate Thickness	Bolt Circle	Bolt Hole Diam.	Diam X Pole Total Length
13" X 26'	13"	26'	#3 gauge	19" sq.	2"	18"	2 3/8"	2" X 90" (incl. L-bend)
13" X 28'	13"	28'	#3 gauge	19" sq.	2"	18"	2 3/8"	2" X 90" (incl. L-bend)
13" X 32'	13"	32'	#0 gauge	19" sq.	2"	18"	2 3/8"	2" X 90" (incl. L-bend)

1.12 Design Load @ Yield

- 13" x 26' = 5,200#
- 13" x 28' = 5,200#
- 13" x 32' = 5,800#

2. MATERIALS -

Other materials shall meet the following requirements:

2.1 Concrete -

The concrete used in the pole base, shall conform to the requirements of DOT STANDARD SPECIFICATIONS, Section 701, 702, 703, and 704. The concrete shall be CLASS 5000, with "WATER-REDUCER ADMIXTURE", installed in ONE MONOLITHIC POUR, with VIBRATION.

2.2 Reinforcing Steel -

Steel reinforcement shall conform to the requirements of DOT STANDARD SPECIFICATIONS, Section 703.1.

The bars shall be of the size and type shown on the Design Details or in the Standards.

2.3 Conduit Elbow -

Conduit Elbows shall be in accordance with FURNISH AND INSTALL ELECTRICAL CONDUIT. Conduit Elbows in pole bases shall be PVC, of the size and type shown on the Plans. As a minimum, THERE SHALL BE AT LEAST ONE (1) CONDUIT ELBOW (2 INCH PVC ELBOW) IN EACH POLE BASE.

2.4 Ground Rod -

Ground rods shall be 5/8 inch by 8 feet (minimum) Copper-Clad. A No. 6 AWG bare, stranded copper wire shall be used in the ground connection. EACH STRAIN POLE SHALL HAVE ONE (1) GROUND ROD.

2.5 Pole Plugs -

Plugs/Caps, either galvanized or stainless, shall be installed in all un-used holes in steel pole.

2.6 Miscellaneous -

All other hardware or components shall be made of a non-corrosive material, or be of the same material as the item being installed.

3. DESIGN AND DRAWINGS -

3.1 The CONTRACTOR SHALL FURNISH pole design details and shop-drawings in sufficient detail for complete evaluation and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing.

NOTE: CATALOG CUTS ARE REQUIRED.

3.2 The Contractor shall also provide a certification from the Manufacturer, that all Strain Poles provided under this item shall have a guaranteed minimum yield strength of 55,000 P.S.I.

4. WARRANTY AND QUALITY CONTROL -

4.1 Warranty - The Contractor/Manufacturer shall warrant the poles and all associated hardware to be free from defects in material and workmanship for a period of two (2) years from date of shipment. Any defects within this period shall be repaired or replaced by the Manufacturer or Vendor, at total cost to the Manufacturer or Vendor, including labor, parts and transportation.

4.2 Performance Testing - The Department reserves the right to receive on demand a test report from an independent laboratory certifying that the equipment furnished meets these specifications, at no costs to the Department. The bidder shall also provide a certification from the manufacturer that all strain poles shall have a guaranteed minimum yield strength, (mill certified), of 55,000 PSI.

4.3 Rejection - The Department reserves the right to reject an entire shipment of poles covered by this specification and project, if ten percent (10%) or more are found to be defective within a 30 day period following receipt of materials.

5. CONSTRUCTION METHODS -

5.1 Foundation -

5.1.1 The foundation shall be constructed as shown in the Design Details or the Standards. Generally, it shall be thirty-six (36") inches in diameter, and at least ten (10') feet deep, with a circular reinforcing cage (**either tied together, or tack welded**) and a finished square surface above ground. The top of the foundation shall be even with sidewalk or between 3"-6" above grade when no sidewalk is present. The hole shall be augured (earth-auger), and the concrete poured in UN-disturbed earth. **The steel pole shall not be put in place on foundation for a minimum of two (2) days (48 hours after individual pour) and strain shall not be applied for a minimum of seven (7) days (168 hours after individual pour) or as otherwise directed by the project engineer.** In BED-ROCK, a hole shall be jack-hammered out, and be of sufficient

depth to hold the Anchor Bolts. In WET-LANDS, it may be necessary to line the hole with a heavy walled CAISSON.

5.1.2 The concrete shall be mixed, placed, poured, and tested in accordance with DOT Standard Specifications, Sections 701, 702, 703, 704. The concrete shall be placed in one continuous pour. In WET-LANDS the hole shall be pumped dry.

5.1.3 Where shown on the Plans, or as determined by the location of underground utilities, it may be necessary to excavate a hole BY HAND. NO additional payment shall be made UNLESS an item has been established in the BID or Proposal for UNCLASSIFIED EXCAVATION (hand excavation of hole)--CUBIC YARDS.

5.2 Anchor Bolts -

5.2.1 The Anchor Bolts shall be set using pre-formed templates (wood or metal), to provide a "bolt-circle" in accordance with the Dimension Chart, or with recommendations of the pole Manufacturer. **The templates shall be left in place for two (2) days (48 hours).**

5.3 Conduit Elbows -

5.3.1 Conduit Elbows shall be capped at both ends, and secured in place in the excavation before any concrete is poured. The size and number of elbows shall be that necessary to mate with the incoming runs. Where no conduit is indicated on the Plans, a two (2") inch elbow shall be placed for future use.

5.3.2 All conduit elbows shall extend beyond the side of the finished foundation by approximately twelve (12") inches, in the direction of, and at a depth matching the incoming conduit. Where a conduit elbow is placed for future use, an "X" shall be scribed in the foundation to indicate the side where such conduit enters. The conduit shall protrude three to six (3"-6") inches above the top of the finished concrete foundation. (See Design Details or Standards.)

5.4 Grounding -

5.4.1 Ground Rods and Grounding Wire shall be furnished and installed with each foundation.

5.4.2 The ground rod shall be installed outside of the foundation, as shown on the Design Details or the Standards.

5.4.3 Grounding clamps of brass or bronze shall be used to secure the grounding wire to the ground rod.

5.4.4 A continuous ground wire shall bond all metal parts together--pole ground stud; pedestal pole nut; pole-mounted controller cabinet ground; metal conduits; etc.

5.5 Raking -

5.5.1 Each pole shall be raked away from the line of span wire pull, by adjusting the nuts on the Anchor Bolts.

5.5.2 When final load is applied, there shall be six (6") inches (plus or minus one inch) rake at the top of the pole, opposing the direction of the stress.

5.6 Finishing -

5.6.1 When poles are installed in SIDEWALKS, the entire "square" shall be removed, the concrete pole base installed, and the sidewalk replaced using expansion joint material to separate different "pours" and old/new concrete. This work shall be considered to be incidental, unless an item has been established for CONCRETE PATCH or for SIDEWALK. In concrete islands, a square opening 4 ft x 4 ft for the pole base, shall be saw-cut out; and finally, repaired as stated above. When installed in SIDEWALKS or CONCRETE ISLANDS, the entire area shall be contoured and hand-finished to produce a neat visual line. Sharp edges or pedestrian hazards shall not be allowed.

5.7 Repair -

5.7.1 Galvanized surfaces (poles) which have been scratched or abraded so that bare metal is exposed, shall be repaired by applying two (2) coats of ninety (90%) percent (minimum) Zinc-rich, cold-galvanizing compound; to the satisfaction of the Engineer.

6. **METHOD OF MEASUREMENT** -

Furnishing and installing traffic signal steel Strain Poles, will be measured by each, of the size(s) specified, erected in place as shown on the plans. This shall include Concrete, Anchor Bolts, Nut Covers, Pole Cap, reinforcing steel, ground rod, ground wire, and all miscellaneous hardware as required.

7. **BASIS OF PAYMENT** -

Furnishing and installing Strain Poles, accepted, and measured as above, will be paid for at the contract unit price bid for:

13 IN X (26/28/32) FT STEEL STRAIN POLE -- EACH

Which shall be full compensation for furnishing and installing all materials, and incidentals necessary to complete this item as specified.

8. **MANUFACTURER / SUPPLIER** -

Each pole manufacturer/supplier shall have at least (10) year's continuous experience in the manufacture of strain poles and must have a full time registered professional engineer on staff.

STEEL POLE WITH MAST-ARM

DESCRIPTION - This work shall consist of furnishing (by others) and installing steel Traffic Signal Poles with Mast-Arm(s). Concrete footings with reinforcing steel, anchor bolts, ground rods, conduit elbows, and miscellaneous hardware shall be installed with each pole as required. **Steel mast-arm poles, its components, adapter plates and foundations shall be stamped and sealed by a licensed South Carolina Professional Engineer.**

1. DESIGN CRITERIA -**1.1 AASHTO Standards -**

The Mast-Arm traffic signal Pole shall meet the requirements of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals"; American Association of State Highway And Transportation Officials (AASHTO), 2001 edition and 2002 interim supplement. All components of the Mast-Arm Pole assemblies shall be designed to the following:

25-year mean recurrence interval,

Basic wind speed:

- (See attached map for SC Coastal Region wind zone requirements and/or AASHTO Section 3.8.2, Figure 3-2)

Ice load included,

Fatigue category II,

Natural wind gust pressure loads included, and

Truck-induced gust pressure loads included.

1.2 Minimum Assumptions -

For design, traffic signal heads shall be assumed to be one-way, twelve-inch, aluminum, and be rigidly attached. For design purposes, it shall be assumed that, at the end of the Mast-Arm, there is mounted a five-section cluster signal; and, depending on arm length, three-section signals at twelve feet and at twenty-four feet toward the Pole-Shaft. Signs shall be assumed next to each signal. The traffic signs assumed shall be 30 x 36 inches, and shall be rigidly attached.

2. DESIGN REQUIREMENTS-**2.1 Anchor Bolts -**

With each steel pole with mast arms, provide hooked anchor bolts at least 90 inches long. The top 12 inches of the anchor bolt shall be threaded and hot dipped galvanized. (2) hot dipped galvanized nuts and (2) washers per anchor bolt shall be provided.

2.2.1 Adapter Plate -

Note: Adapter plate, bolts, nuts, and washers not required if steel pole with mast arm is designed to be supported by current SCDOT signal foundation (concrete foundation with (4) 2" dia. anchor bolts on a 18-inch dia. bolt circle), and the design meets the design criteria requirements of this specification.

2.2.2 With each steel pole with mast arms, provide a 2" thick, hot dipped galvanized steel adapter to allow a pole with a 19" square base plate and 18" dia. bolt circle to be installed. Plate shall be pre-drilled with (4) 2 3/8" dia. bolt holes on the 18" dia. bolt circle. A 10" dia. minimum hole shall be provided in the center of the adapter plate.

2.2.3 Provide (4) hot dipped galvanized 2" x 10" hex head cap screws, (12) nuts, and (8) washers in a **BURLAP** bag for each adapter plate. Bolts and nuts shall be of sufficient strength to support a 32-foot tall steel pole with steel strain wire supporting signal heads and signs for the intersection in case the steel pole with mast arms is damaged and has to be removed and replaced.

2.2.4 Adapter plate, bolt, and nut selection and design shall be stamped and sealed by a licensed South Carolina Professional Engineer.

2.3 Mast Arm Vertical Clearance -

Unless otherwise shown on the plans, the bottom of the overhead traffic signal mast arm shall provide a minimum vertical clearance over the entire width of the pavement and shoulders of 22'-0".

2.4 Miscellaneous Items

Steel pole with mast arms design drawing shall include the following:

- 4" x 6" minimum reinforced handhole,
- 1/2" coarse thread grounding stud located on interior of pole handhole,
- strain relief j-hook at top of pole, rain cap,
- holes in steel poles and mast arms for wiring to be routed to traffic signals,
- holes for wiring to be protected with full circumference grommets,
- nut covers to be provided to cover anchor bolt nuts,
- tapered poles and mast arms shall taper uniformly along their length
- additional requirements as shown on the signal plans for the intersections

3. MATERIALS -

Other materials shall meet the following requirements:

3.1 Concrete. The concrete used in the pole base shall meet the design by the foundation designer, and shall conform to the requirements of DOT STANDARD SPECIFICATIONS, Section 701, 702, 703, and 704.

3.2 Reinforcing Steel. Steel reinforcement shall conform to the requirements of DOT STANDARD SPECIFICATIONS, Section 703.1.

The bars shall be of the size and type shown on the Design Details or in the Standards.

3.3 Conduit Elbow. Conduit Elbows shall be in accordance with FURNISH AND INSTALL ELECTRICAL CONDUIT. Conduit Elbows shall be installed in pole bases before pouring and shall be PVC, of the size and type shown on the Plans. As a minimum, THERE SHALL BE AT LEAST TWO CONDUIT ELBOW (2 INCH PVC ELBOW) IN EACH POLE BASE. End of conduit shall protrude above top of pole base 6-9 inches.

3.4 Grounding - Ground rods shall be 5/8 inch by 8 feet (minimum) Copper-Clad. A No. 6 AWG bare, stranded copper wire shall be used in the ground connection. EACH POLE SHALL HAVE ONE (1) GROUND ROD (minimum). An adequate ground shall be developed per NEC.

3.5 Signal Brackets. Unless otherwise shown on the plans, rigid signal head mounting brackets shall be used. The bracket shall consist of a top- and bottom-arm, an extruded aluminum vertical tube, a vertical tube clamp, and a mast-arm clamp, with all hardware. The Bracket shall be COMPLETELY RUST PROOF, and shall be fully adjustable in all dimensions and angles.

3.6 Sign Brackets. Where required by the Plans, each sign mounting bracket shall be of the commercial type shown on the Installation Details or the Standards. The bracket shall be rust proof.

3.7 Miscellaneous. All other hardware or components shall be made of a non-corrosive material, or be of the same material as the item being installed.

4. DESIGN AND DRAWINGS -

4.1 The CONTRACTOR SHALL FURNISH pole design details, calculations, and shop-drawings in sufficient detail for complete evaluation and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing. The design, calculations, and shop drawings shall be stamped and sealed by a licensed South Carolina Professional Engineer.

4.2 The CONTRACTOR SHALL FURNISH a concrete foundation design details and calculations adequate for local soil type and steel pole with mast arm loads shall be designed. The design and calculations shall be stamped and sealed by a licensed South Carolina Professional Engineer.

NOTE: CATALOG CUTS ARE REQUIRED FOR REVIEW AND APPROVAL PRIOR TO FABRICATION.

5. WARRANTY -

The CONTRACTOR shall furnish the Engineer with all warranties on equipment and material offered by the Manufacturer as normal trade practice.

6. CONSTRUCTION METHODS -

6.1 Foundation.

6.1.1 The foundation shall be constructed with a circular reinforcing cage (**either tied together, or tack welded**) installed. The finished square surface above ground shall be as shown on the Installation Details or the Standards. The hole shall be augured (earth-auger), and the concrete poured in UN-disturbed earth. **The steel pole shall not be put in place on foundation for a minimum of two (2) days (48 hours after individual pour) and mast-arm or strain shall not be applied for a minimum of seven (7) days (168 hours after individual pour) or as otherwise directed by the project engineer.**

6.1.2 The concrete shall be mixed, placed, poured, and tested in accordance with DOT Standard Specifications, Sections 701, 702, 703, 704. The concrete shall be placed in one continuous pour. The hole shall be pumped dry in wet-lands.

6.1.3 Where shown on the Plans, or as determined by the location of underground utilities, it may be necessary to excavate a hole BY HAND. No additional payment shall be made.

6.2 Anchor Bolts -

The Anchor Bolts shall be set using pre-formed templates (wood or metal), to provide a "bolt-circle" in accordance with the requirements in 2.1 above. **The templates shall be left in place for two (2) days (48 hours).**

6.3 Conduit Elbows -

6.3.1 Conduit Elbows shall be capped at both ends, and secured in place in the excavation before any concrete is poured. The size and number of elbows shall be that necessary to mate with the incoming runs. Where no conduit is indicated on the Plans, a two (2") inch PVC elbow shall be placed for future use.

6.3.2 All conduit elbows shall extend beyond the side of the finished foundation by approximately twelve (12") inches, in the direction of, and at a depth matching the incoming conduit. Where a conduit elbow is placed for future use, an "X" shall be scribed in the foundation to indicate the side where such conduit enters. The conduit shall protrude six to nine (6"-9") inches above the top of the finished concrete foundation.

6.4 Grounding -

6.4.1 Ground Rods and Grounding Wire shall be furnished and installed with each foundation.

6.4.2 The ground rod shall be configured with the foundation, as shown on the Design Details or the Standards.

6.4.3 Grounding clamps of brass or bronze shall be used to secure the grounding wire to the ground rod.

6.4.4 A continuous ground wire shall bond all metal parts together--pole ground stud; pedestal pole nut; pole-mounted controller cabinet ground; metal conduits; etc.

6.5 Adapter Plate -

6.5.1 The adapter plate, if required, shall be placed between the leveling nuts and the steel pole with mast arms base.

6.5.2 The **BURLAP** bag containing the adapter plate nuts, bolts, and washers shall be placed inside each steel pole with mast arms.

6.6 Raking -

6.6.1 Each Pole shall be raked away from the line of the Mast-Arm pull, by adjusting the nuts on the anchor bolts.

6.6.2 When final load is applied, there shall be an essentially vertical appearance as determined by the Engineer.

6.7 Finishing -

6.7.1 When poles are installed in SIDEWALKS, the entire "square" shall be removed, the concrete pole base installed, and the sidewalk replaced using expansion joint material to separate different "pours" and old/new concrete. This work shall be considered to be incidental, unless an item has been established for CONCRETE PATCH or for SIDEWALK. In concrete islands, a square opening 4 ft x 4 ft for the pole base, shall be saw-cut out; and finally, repaired as stated above. When installed in SIDEWALKS or CONCRETE ISLANDS, the entire area shall be contoured and hand-finished to produce a neat visual line. Sharp edges or pedestrian hazards shall not be allowed.

6.8 Repair -

6.8.1 Poles which have been scratched or abraded so that bare metal is exposed, shall be repaired to the satisfaction of the Engineer. Holes drilled in poles or Mast-Arms shall likewise be repaired.

7. **METHOD OF MEASUREMENT** -

Furnishing (by others) and Installing traffic signal steel Poles with Mast-Arm will be measured by each, erected in place as shown on the plans. This shall include Adapter Plate (if applicable), Concrete, Anchor Bolts, Nut Covers, Pole Cap, reinforcing steel, ground rod, ground wire, and all miscellaneous hardware as required.

8. **BASIS OF PAYMENT** -

Furnishing (by others) and Installing Steel Poles with Mast-Arm, accepted, and measured as above, will be paid for at the contract unit price bid for:

INSTALL STEEL POLE WITH MAST ARM - EACH

Which shall be full compensation for furnishing and installing all materials, and incidentals necessary to complete this item as specified.

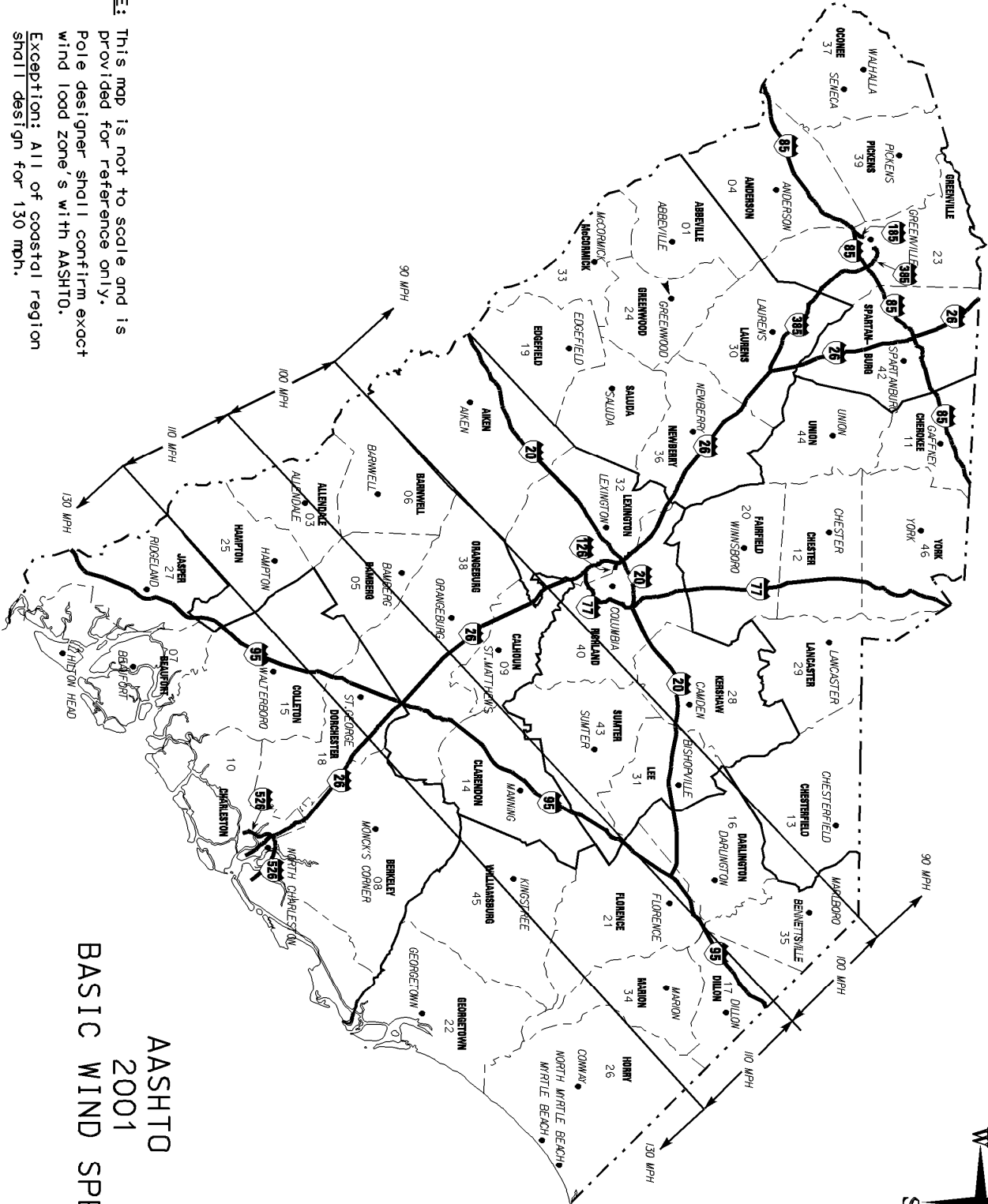
2001 AASHTO Design Specification Form

Name: _____ Title: _____

Organization: _____ Phone #: _____

Project Site Location: _____, _____

1. **Basic Wind Speed** – AASHTO Section 3.8.2 and Figure 3-2 _____ mph
(See Attached Map)
2. **Design Life or Recurrence Interval** – AASHTO Section 3.8.3 and Table 3-3 recommends the following design life intervals for various structure types and locations, unless otherwise specified by the owner. (check one only)
- _____ 10 years for roadside sign structures.
- _____ 25 years for luminaire support structures less the 49.2' in height and signal structures where locations and safety considerations permit, and when approved by the owner.
(* SCDOT minimum standard*)
- _____ 50 years for luminaire support structures exceeding 49.2' in height and overhead sign structures.
- _____ 100 years for critical locations.
3. **Fatigue Category** – AASHTO Section 11.6 and Table 11-1 (check one only)
- _____ Category I For critical cantilevered support structures installed on major highways, which present a high hazard in the event of failure.
- _____ Category II For all cantilevered support structures installed on major highways and all cantilevered support structures installed on secondary highways.
(* SCDOT minimum standard*)
- _____ Category III For cantilevered support structures installed at all other locations.
4. **Galloping loads** – AASHTO Section 11.7.1 (check one only)
- _____ Design cantilevered support structures to resist periodic galloping forces.
- _____ Do not design cantilevered support structures to resist periodic galloping forces. An owner approved mitigation device will be attached to each structure. Mitigation device shall be the sole responsibility of the owner.
- _____ Do not design cantilevered support structures to resist periodic galloping forces. The owner will install an approved mitigation device only if a structure displays a galloping problem. The mitigation device must be installed as quickly as possible after the galloping problem appears. (* SCDOT minimum standard*)
5. **Truck loads** – AASHTO Section 11.7.4 (check one only)
- _____ Include truck-induced gust loads. The specified average truck speed is _____ mph. _____ AASHTO equations are based on a truck speed of 65 mph, but also allow for a design pressure reduction for lower speeds. (* SCDOT minimum standard*)
- _____ Do not include truck-induced gust loads as allowed by the owner.



**AASHTO
2001
BASIC WIND SPEEDS**

NOTE: This map is not to scale and is provided for reference only. Pole designer shall confirm exact wind load zone's with AASHTO.

Exception: All of coastal region shall design for 130 mph.

NO SCALE

FURNISH AND INSTALL CONCRETE STRAIN POLE

DESCRIPTION – This work shall consist of furnishing and installing traffic signal pre-stressed concrete strain poles, of the sizes shown, and at the locations shown on the Plans, or as established by the Advanced Systems Coordinator (ASC). These poles shall be of the type intended for direct embedding, with the hole back filled with concrete.

Ground rods, conduit elbows and miscellaneous hardware shall be furnished and installed with each pole as required.

1. DESIGN REQUIREMENTS FOR POLE -

1.1 Scope – The following covers the design, fabrication and installation of pre-stressed concrete strain poles, to be used for supporting steel cable suspended traffic signals or supporting lane control signs. **ALL CONCRETE STRAIN POLES PROVIDED FOR ANY INDIVIDUAL PROJECT SHALL BE FROM THE SAME MANUFACTURER.**

Each strain pole assembly shall consist of:

1. A round pre-stressed hollow concrete shaft,
2. A pole cap, and
3. Miscellaneous hardware as specified

1.2 Design -

1.2.1 Assumptions, designs and the poles shall meet or exceed the specifications stated in the publication “American Association of State Highway and Transportation Officials” (AASHTO); “Standard Specifications For Structural Supports For Highway Signs, Luminaires And Traffic Signals” and in particular, Section 6 “Pre-Stressed Concrete Design”, Rev. 1994 (or latest edition). Stress in concrete due to pre-stressing shall be within the limits stated in the AASHTO Standard. Loss of pre-stress shall be calculated using AASHTO methods. Further, the manufacturer shall provide documentation showing the permeability/water-absorption of their product. Other procedures shall be according to the American Concrete Institute (ACI).

1.2.2 Poles shall be designed and constructed so that all wiring and grounding facilities are concealed within the hollow poles. All hand holes, wire inlets/outlets, inserts for pole steps, through bolt holes and the ground wire shall be cast into the pole during the manufacturing process. **NO FACTORY NOR FIELD DRILLING SHALL BE ALLOWED AFTER THE POLES HAVE BEEN STRIPPED FROM THEIR MOLDS.**

1.2.3 Design Category –

Poles shall be designed in accordance with the following requirements, to provide the Mandatory Ultimate Ground Line Moment and with the cable attachment heights stated below. As given, the design shall assume:

<u>OVERALL POLE LENGTH</u>	<u>EMBEDMENT (below ground line)</u>
(35 ft)	(8 ft)
(40 ft)	(10 ft)
(45 ft)	(11 ft)

The Defined Attachment Height = Overall Pole Length – Embedment. The design shall assume a worst case strain (pull) of 22,200 Newtons (5000 pounds force) applied at the top of the pole (the design Defined Attachment Height).

1.2.4 SCDOT design method. A worst case application of AASHTO and ACI “Ultimate Strength Design” has been used. M is moment, T is torsion, U is ultimate.

The formula used: $(1.25*M / \phi M_u) + (1.25*T / \phi T_u)^2 \leq 1.0$. The contribution of torsion was neglected. A ϕ of 0.90 was used. Substituting gives $M_u > (1.25/0.9) * M$ or $M_u > 1.39 M$. We increased the 1.39 multiplier by 7 percent, to allow for torsion, fatigue and possible accidental vehicle damage.

Design Formula: $M_u > 1.5 M$

1.3 Pole Materials -

1.3.1 Concrete - The concrete mix shall be designed to achieve a minimum twenty-eight (28) day compressive strength (f_c) of 58,650 kPa (8,500 psi). Cement shall conform to the latest requirement of Type I or Type III Portland cement in accordance with ASTM C-150. The maximum size aggregate may be is 19 mm. (3/4 in.) or $\frac{3}{4}$'s of the clear spacing between the main reinforcing steel and the surface of the pole. Any water reducers, retarders or accelerating admixture used shall conform to ASTM C-494. The water used shall be free from foreign materials in amounts harmful to concrete or embedded steel. The compressive strength at release of pre-stress (f_{ci}) shall be 31,050 kPa (4,500 psi).

1.3.2 Reinforcing Steel – **NO** deformed steel reinforcement (ASTM A-615) shall be used in the manufacturing process.

1.3.3 Pre-stressing Steel – Pre-stressing steel stranded rope cable, which shall conform to uncoated 12.7 mm (0.5 inch), 7 wire, stress relieved strand (including low relaxation) of 1,201,500 Newtons (270,000 pound strain) grade, ASTM A-416. The minimum number of strands shall be eight (8) strands.

1.3.4 Spiral Reinforcement – Steel wire spiral reinforcement shall conform to ASTM A-82 and shall be of minimum diameter 0.150 inch. The pitch of the spiral reinforcement shall be on 2 inch centers for the first and last 3 feet of the pole, and 6.5 inch centers for the remaining portion of the pole. These requirements are more stringent than AASHTO.

1.3.5 Hardware – All structural steel shall conform to ASTM A-36 and be hot-dip galvanized per ASTM A-123. Hand hole frames and covers and all inserts shall be zinc alloy AC41A, ASTM B-240. All bolts, nuts, washers and other fasteners shall be stainless steel or be hot-dip galvanized per ASTM A-153.

1.4 Manufacture -

1.4.1 All manufacturing tolerances, details of reinforcement and finishes shall be in accordance with the "Guide Specification For Pre-Stressed Concrete Poles", as published in the May-June 1982 issue of the "Journal Of The Pre-Stressed Concrete Institute".

1.4.2 All poles shall be pre-stressed and be manufactured by the centrifugal spinning process using a mold. The purpose of this requirement is to insure a minimum twenty-eight (28) day compressive strength of 8,500 psi, and to provide the densest possible surface finish.

1.4.3 Forms shall be designed to provide a continuous outside taper of 0.180 inches per foot of length. Forms shall also provide a minimum of 1 inch of concrete cover over the pre-stressing strands.

1.4.4 Poles shall have a smooth, natural form finish, concrete soft gray in color (no dyes or stains).

1.4.5 Poles shall be round in cross section, with a hollow center and shall be of one piece construction.

1.4.6 Poles shall not have any exposed steel at either top or the butt end. Steel strands, both top and butt end, shall be burned back a minimum of 0.75 inch and the resulting hole shall be completely sealed with epoxy.

1.4.7 Pole bottom ends shall be plugged with 12 inches of concrete at the butt end, which shall also have a 2 inch diameter drain hole through that plug.

1.5 Pole Features –

Contact the Traffic Signal & Systems Engineer at (803) 737-1050 for: “Pole Data Tabulation Sheet”, “Concrete Pole Openings, Thru-Bolts & Couplings” for the height and compass orientation of pole features; and “Typical Concrete Pole Orientation” for intended usage.

Each pole shall include the features listed below.

1.5.1 Pole Cap – Each pole shall be supplied with a pole cap or top, which shall be made of plate aluminum. (Galvanized steel is NOT acceptable.)

1.5.2 Wire Support – A wire support consisting of a diametric reinforcing bar shall be cast inside the pole about 6 inches from the top. This bar can also be used to anchor the pole cap if necessary.

1.5.3 Upper Handhole – A reinforced hand hole frame, complete with flush cover, with a minimum size of 3.5 x 8 inches, shall be cast into pole approximately 1’ – 2” from the top of pole at 270°. (orientate counter-clockwise)

1.5.4 Couplings – For weather head installation and entrance of the electrical cables, two (2) 2 inch I.D. conduit couplings shall be cast into the pole at 0° and 90° (orientate counter-clockwise) approximately 1’-2” from the top of pole and one (1) 2 inch I.D. conduit coupling 2’-10” from the top of the pole at 0°.

1.5.5 Holes – Through-holes, for attaching steel span cable using appropriate through-bolt hardware, shall be at 0°, 90°, 180°, and 270°. The upper holes should be approximately 1’-10” from the top of pole and the lower holes should be approximately 2’-4” from the top of the pole. **NO PVC** is required in holes so that each level of span wire through bolt hardware can be used in multiple directions.

1.5.6 Grounding – A No. 4 AWG stranded copper ground wire shall be cast into each pole and be attached to the pre-stressed steel by bonding connectors. The embedded ground wire shall be terminated near the top of the pole and at a point near the bottom, approximately 9 inches below the ground line. Both terminations shall be made to a “copper tank ground” which provides a 0.5 inch tapped insert on the pole face for grounding attachment to spans wires at the top and to the driven ground rod at the base.

1.5.7 Pedestrian Features – For possible pedestrian signal head assembly, each pole shall have four (4) 1 inch holes for wiring the signals that will be banded onto the pole at a height 10 feet above the ground line at 0°, 90°, 180°, and 270°.

For possible pedestrian push buttons, each pole shall have four (4) 1 inch holes for wiring a push button that will be banded onto the pole at a height 3’- 6 inches above the ground line at 0°, 90°, 180°, and 270°.

1.5.8 Pole Labeling – Every pole shall have an embedded “Builders Plate” (name plate) of brass or aluminum with raised or stamped letters stating the manufacturer, the date of manufacture, job identification, the length and diameter of the pole and the ultimate ground line moment capacity. The name plate shall be cast into the outside pole wall about 5 feet above the ground line.

1.5.9 Rouosting Holes – A 1.5 inch “CANT” hole, completely through the pole and lined with PVC conduit shall be cast into each pole at a height 4 feet above ground line. The purpose shall be to permit inserting a pry-bar to turn the pole for proper orientation with the intersection.

There shall also be a Pick-Up point hole at the defined distances from the top of the pole found on the "Concrete Pole Openings, Thru-Bolts & Couplings".

1.5.10 Lower Hand Hole – The compass location of the hand hole defines the zero (0) degree point. Each pole for traffic signal support shall have a reinforced hand hole frame, complete with flush cover, with a minimum size of 3.5 x 8.5 inches, shall be cast into the pole approximately 1'-6 inches above the ground line.

1.5.11 Pole Mounted Cabinet (all poles) - For possible controller cabinet installation, two (2) 3 inch I.D. conduit couplings shall be cast into the pole at 90° and 270° approximately 1'-6 inch from the ground line. (**Note: These couplings flank the lower hand hole**)

1.5.12 U.G. Conduit Entrance – In each signal pole, there shall be cast in two (2) rectangular underground cable entrance openings (conduit entry hole) minimum size of 4 x 10 inches located approximately 1' – 6 inch below the ground line, just above embedding concrete at 0° and 270 degrees.

1.5.13 Pull Rope/Wire – The manufacturer shall furnish inside each pole a nylon or polypropylene rope or stainless steel wire so electrical wires may be pulled in installed pole. The rope or wire shall extend from the conduit opening near the base to the top of the pole.

1.5.14 Miscellaneous – Provisions shall be furnished for any other electrical or mechanical components not specifically stated, but required to complete the project as shown on the plans.

2. **MATERIALS** – Other materials shall meet the following requirements:

2.1 Concrete – The concrete used to embed the pole shall conform to the requirements of SCDOT Standard Specifications, Sections 701, 702, 703 and 704. The concrete shall be SCDOT Class A (3,000 psi @ 28 days) installed in one monolithic pour with vibration.

2.2 Conduit Elbow – Conduit elbows shall be in accordance with furnish and install electrical conduit. Conduit elbows in pole bases shall be PVC of the size and type shown on the plans. If no other conduit is shown as a minimum, there shall be at least one (1) conduit elbow (i.e. a 50 mm (2 inch) PVC elbow) placed in each pole base.

2.3 Ground Rod – Ground rod(s) shall be 16 mm by 2.4 meters (5/8 inch by 8 feet) (minimum) copper clad. A No. 6 AWG bare stranded copper wire shall be used in the ground connection. Each strain pole shall have at least one (1) ground rod.

2.4 Miscellaneous – All other hardware or components shall be made of a non-corrosive material or be of the same material as the item being installed.

2.5 Reinforcing Steel – Not usually needed for a concrete pole.

3. **DESIGN, DRAWINGS AND QUALITY CONTROL**

3.1 Prior to being approved for fabrication, the Contractor shall furnish from the manufacturer to the Engineer, complete stress computations, calculations, pole design details and design drawings in sufficient detail for complete evaluation and comparison with these Specifications. These submittals shall indicate the dimensions and shape of all individual structural and electrical features, their relative location on each pole and their relationship with each other. Drawings shall be made as close to scale as possible and with all details large enough to be self explanatory. Any exceptions to these Specifications must be stated in writing. When computer programs have been used during the design process, the printouts of the programs or a copy thereof, shall be provided to the engineer.

NOTE: CATALOG CUTS ARE REQUIRED

3.2 The manufacturer shall provide documentation stating the permeability and/or water absorption of their concrete pole.

3.3 The CONTRACTOR shall provide a written certification from the intended manufacturer that all components of strain poles provided under this item have been designed and manufactured in complete accordance with these specifications and the approved design drawings, including the strength of the concrete. The certification letter shall be signed by an officer of the company.

3.4 Poles must be manufactured within the United States at a facility solely owned by a company incorporated in the United States. **The manufacturer must have a minimum of ten (10) years experience in the design and production of centrifugally spun concrete poles shall have a full time registered professional engineer on staff.** Steel used shall comply with current Federal laws limiting foreign steel.

3.5 By proposing to furnish poles for this project, the manufacturer implicitly grants the right of entry and inspection to the Engineer (or designated representative) of SCDOT. If requested, each of the component materials involved in the production of these poles must be sampled, tested and approved by the SCDOT Materials Laboratory prior to the start of production. In addition the total production process, including curing, shall be subject to inspection and approval.

3.6 Testing – The Department, at the discretion of the Engineer, may direct that one (or more) randomly chosen poles shall be shipped directly to a testing facility other than the depot. This may be one of the SCDOT Materials Laboratories or an independent testing facility. There, the pole may be tested to destruction. This “test pole” shall be paid for at the contract unit price.

4. WARRANTY -

4.1 The Contractor/Manufacturer shall warrant the poles and all associated hardware to be free from defects in material and workmanship for a period of two (2) years from date of shipment. Any defects within this period shall be repaired or replaced by the Manufacturer or Vendor, at total cost to the Manufacturer or Vendor, including labor, parts and transportation.

5. CONSTRUCTION METHODS –

A hole shall be augured, the concrete pole lowered in and the hole back filled with concrete up to the bottom of the underground conduit entrance while being supported.

5.1 Augured Hole – The embedding foundation shall be constructed as shown in the design details or the standards. A hole shall be augured in undisturbed earth of the diameter and depth (at least) listed in the table below, or as recommended by the manufacturer (which ever is larger). The following table lists minimum values.

GENERAL USE POLE LENGTH	SPECIAL USE POLE DIAMETER	MINIMUM AUGURED HOLE DIAMETER	AUGURED HOLE DEPTH
40 FT	12-17 IN	36 IN	10 FT
45 FT	18-23 IN	42 IN	11 FT
50 FT	24-31 IN	48 IN	12 FT

The depth and diameter shall be measured by a tape measure, NOT guess work.

In bed-rock, a hole shall be jack-hammered out and be of sufficient depth to hold the design embedded length and a diameter to provide 76 mm (3 inch) clearance all around the concrete pole.

In wet-lands or loose-sand, it may be necessary to line the hole with a heavy walled Caisson. In Wet-lands or loose-sand, it may also be necessary to auger a larger hole.

5.2 Crane -

5.2.1 Caution – Concrete poles are very heavy, quite long and are difficult to handle. Transportation, site handling and erection shall be performed with acceptable equipment and methods and by qualified personnel. The Contractor is cautioned to have cranes, pole trailers and sufficient manpower to perform this work with total safety to the crew and to the motoring public. The Contractor shall review the manufacturer's shop drawings to identify proper pick-up points for lifting.

5.2.2 The pole shall be lifted into place, using a sling. A single point lift shall NEVER be used and such misuse could result in the Engineer rejecting that pole. Next, to lower the pole into the hole, a bar shall be inserted into the chocker hole (1/3 down the pole to prevent the strap from slipping) and a single strap shall raise one end of the pole vertically and jostle the butt end into the hole.

5.2.3 The pole shall be lowered into the hole and be held vertically by the crane. Using a pry bar through the "CANT" hole, the pole shall be rotated so that all holes are at the proper compass orientation angle with the street and incoming conduit runs.

5.2.4 Each pole shall be slightly "raked away" (leaned away) from the direction of the span wire pull. For a concrete pole this will typically mean that the back side of the pole is vertically plumb.

5.3 Concrete – The pole hole shall be back filled with concrete. The concrete shall be mixed, placed, poured and tested in accordance with SCDOT Standard Specifications, Sections 701, 702, 703 and 704. The concrete shall be placed in one continuous pour. In wet-lands or where springs are encountered the hole shall be pumped dry. Care shall be taken during the pour to plug/cover the underground cable entrance hole and any conduit openings.

5.4 Support – The concrete pole shall be vertically supported by a pole or boom truck until the poured embedding concrete begins to set. This will typically be 15 to 20 minutes. No stress (steel cables) shall be placed on the pole until the poured embedding concrete has hardened (typically 72 hours).

5.5 Hand Excavation – Where shown on the plans, or to determine the location of underground utilities, it may be necessary to excavate a hole by hand. No additional payment shall be made unless an item has been established in the bid or proposal for "Unclassified Excavation" (hand excavation of hole) cubic yards (meters).

5.6 Openings – After installation, the Contractor shall plug or cap all unused openings and couplings on the concrete pole using a threaded plug or a cemented PVC cap.

5.7 Conduit Elbows -

5.7.1 Conduit elbows shall be capped at both ends and secured in place in the excavation before any concrete is poured. The site and number of elbows shall be that necessary to mate with the incoming runs.

Where the concrete pole is adjacent to a base mounted controller cabinet, then two (2) 76 mm (3 inch) conduits may be run to the nearby hand box (rather than one (1) 102 mm (4 inch) shown in the Standards. This is due to the smaller size of the conduit opening in the concrete pole.

Where no conduit is indicated on the plans, a 50 mm (2 inch) elbow shall be placed for future use.

5.7.2 All conduit elbows shall extend beyond the side of the finished foundation by approximately 305 mm (12 inches) in the direction of and at a depth matching the incoming conduit.

5.8 Grounding -

5.8.1 Ground rod(s) and grounding wire shall be furnished and installed with each concrete pole.

5.8.2 The ground rod shall be driven adjacent to the poured concrete embedding as shown on the design details or standards.

5.8.3 Grounding clamps of brass or bronze shall be used to secure the pole grounding wire to the grounding rod.

5.8.4 A continuous ground wire shall bond all metal parts together – pole ground stud, pedestal pole nut, pole mounted controller cabinet ground, metal conduits, etc.

5.9 Clean Up -

5.9.1 After the pole and conduit have been installed, then the site shall be restored to prime condition. The area surrounding shall be back filled with topsoil, raked level and seeded. If the area is sloped, then landscape turf shall be used.

5.9.2 When poles are installed in sidewalks, the entire square shall be removed, the concrete pole installed and embedded in poured concrete, then the hole back filled with tamped dirt to 102 mm (4 inches) below the ground line and the sidewalk replaced using expansion joint material to separate different pours and old/new concrete. This work shall be considered to be incidental unless an item has been established for concrete patch or for sidewalk. In concrete islands, a square opening 1.2 x 1.2 meters (4 x 4 feet) for the pole base shall be saw cut out and finally repaired as stated above. When installed in sidewalks or concrete islands, the entire areas shall be contoured and hand finished to produce a neat visual line. Sharp edges or pedestrian hazards shall not be allowed.

5.10 Repair -

5.10.1 Concrete surfaces which have been chipped, chunked or damaged shall be patched to the satisfaction of the Engineer with a commercial grade vinyl or epoxy based on concrete patching compound, according to manufacturer's instructions.

5.10.2 Galvanized surfaces which have been scratched or abraded so that bare metal is exposed shall be repaired by applying two (2) coats of ninety (90%) percent (minimum) zinc rich, cold galvanizing compound to the satisfaction of the Engineer.

6. METHOD OF MEASUREMENT –

Furnishing and installing concrete strain poles will be measured by EACH of the length specified, erected in place as shown on the plans. This shall include concrete, pole cap, ground rod, ground wire and all miscellaneous hardware as required.

Conduit elbows shall be considered to be incidental to the installation of the concrete pole.

7. BASIS OF PAYMENT –

Furnishing and installing concrete strain poles, accepted and measured as above, will be paid for at the contract unit price.

(40 / 45 / 50) FEET (12.20 / 13.73 / 15.25) METERS CONCRETE STRAIN POLE – EACH

Which shall be full compensation for furnishing and installing all materials, equipment, labor and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL STEEL CABLE

DESCRIPTION - This work shall consist of furnishing and installing splice-free lengths of Steel Cable with cable supports, for mounting signal heads, signs, interconnect runs, installing back guys, etc., at locations shown on the Plans or as established by the Engineer.

1. MATERIALS -

Materials shall meet requirements listed below:

1.1 Fabrication -

1.1.1 Steel Cable shall be fabricated of seven (7) steel wires, Class A double galvanized in accordance with ASTM A-475, and twisted into a single concentric strand to conform with the following schedule:

Diameter mm	(inches)	Strand Size (AWG)	Tensile Strength Newtons (pounds)
6.35	(1/4)	14	14,011 (3,150)
9.53	(3/8)	11	30,913 (6,950)
11.1	(7/16)	9.5	41,488 (9,350)
12.7	(1/2)	8	53,376 (12,000)

1.2 Usage -**1.2.1 Span Wire -**

All Steel Cable used as span wire shall be 9.53 mm (3/8 inch) in diameter, unless otherwise noted on the Plans.

1.2.2 Messenger Wire -

All Steel Cable used as messenger shall be 6.35 mm (1/4 inch) in diameter, unless otherwise noted on the Plans.

1.2.3 Tether Wire -

All Steel Cable used as tether wire shall be 6.35 mm (1/4 inch) in diameter, unless otherwise noted on the Plans.

1.2.4 Back Guy -

All Steel Cable used for back guying shall be 9.53 mm (3/8 inch) in diameter, unless noted otherwise on the Plans.

1.3 Cable Supports -**1.3.1 Aluminum Tie-wrap -**

Shall be Flat Aluminum Armor Tape, 1.2 mm (0.05") Thick X 7.6 mm (0.30") Wide, typically furnished in 4.5 kg (10 pound) coils.

1.3.2 Where specifically required, Support Rings (also called "cable rings", "messenger rings") shall be galvanized in accordance with ASTM A-153, and the design approved by the Engineer, and shall be 3 to 8 cm (2 to 3 inches) in diameter (to contain the Electrical Cables), and sized to specifically match the Steel Cable.

1.4 Miscellaneous Hardware -

1.4.1 All hardware and fittings shall be of the type shown on the Standards or the Construction and Installations Details.

1.4.2 All hardware and fittings shall be made of galvanized steel or non-corrosive metal. The tensile strength of all hardware shall be equal-to or greater-than the Steel Cable installed.

1.4.3 All thimble-eye and oval eye-bolts used to connect the automatic compression dead-end clamps to wooden poles, shall be (5/8 inch) diameter. Fiberglass insulators shall be fabricated from epoxy-resin impregnated fiberglass strands, and have a tensile strength fifty (50%) percent greater than the Steel Cable.

2. CERTIFICATION -

2.1 The CONTRACTOR SHALL FURNISH a Certification from the Manufacturer or Vendor, that the Steel Cable has been tested to meet or exceed the required tensile strength.

3. CONSTRUCTION METHODS -

3.1 Span Wire -

3.1.1 General -

All Span Wire shall be installed as shown the Standards, or on the Construction and Installation Details. Note that different methods and materials are required for Wood Poles and Steel Poles.

A. Before erecting the Span Wire, the Contractor shall determine the length of cable required to span the distance indicated on the Plans. Sufficient additional length shall be allowed to compensate for sag, pole connections, and adjustments, to make the whole assembly consistent with the Design Details, or the Standards. NO MID-SPAN SPLICES SHALL BE PERMITTED.

B. The Contractor shall set the Span Wire so that the height of the installed signal heads, including all hardware, shall conform to the clearances shown on the Design Details or the Standards, or as directed by the Engineer.

C. The Span Wire shall not be permanently "tied-off" until all signal heads, signs, and cables are in place.

D. The Contractor shall not erect any Span Wire which lays on, or is likely to rub a Utility Company's cable. If a Span Wire, as erected, is within 15 cm (6 inches) of any other cable, wire, or structure, it shall be protected with plastic wire-guards.

E. When required by the Utility Company, or by the applicable electrical Code, strain-type fiberglass insulators shall be installed.

3.1.2 Cables from STEEL POLES -

Steel Poles are essentially electrical conductors.

A. A Roller Type Pole Clamp shall be used, attached at the proper height.

B. The free-end of the cable shall be secured with a 15 cm (6 inch) galvanized steel clamp, with 16 mm (5/8 inch) galvanized bolts. The clamp shall be placed approximately 30 cm (1 feet) from the pole. Cable-grips are not permitted.

C. The ends of the cable shall be covered with "servisleaves" to prevent unraveling.

D. The SAG shall be THREE (3%), TO FIVE (5%) PERCENT, fully loaded.

3.1.3 Cables from WOODEN POLES -

Wooden poles are essentially electrical insulators, and thus require extensive GROUNDING and BONDING procedures, as shown on the Construction and Installation Details, and the Standards.

- A. The SAG shall be typically FIVE (5%) PERCENT, fully loaded.
- B. The height of attachment shall be sufficient to provide the required road-clearance, including sag.
- C. Shall be installed in accordance with the requirements of the Utility Company.
- D. May require the installation of a back guy assembly as required in FURNISH AND INSTALL BACK GUY.
- E. Shall be electrically bonded.

3.2 Messenger Wire -

3.2.1 Where Messenger Wire is attached to traffic signal poles, it shall be installed in the same manner as specified for span wire, but with relatively little sag.

3.2.2 Where Messenger Wire is attached to utility poles, it shall be installed in accordance with the UTILITY COMPANY'S SPECIFICATIONS.

3.3 Tether Wire -

Where Steel Cable is specified to tether signal heads and/or traffic signs, it shall be installed in the same manner as specified for span wire, but with relatively little sag.

3.4 Back Guy -

See FURNISH AND INSTALL WOOD POLES. See FURNISH AND INSTALL BACK GUY. See the CONSTRUCTION AND INSTALLATION DETAILS.

3.5 Cable Supports -

3.5.1 Cable supports shall be used to support electrical cables from span wire and messenger wire. Cable Supports shall be spaced at 25 CM (10 INCH) INTERVALS.

3.5.2 When Aluminum Tie-Wraps are used, they shall be installed by wrapping 3-full turns TIGHTLY around the bundle formed by the steel cable and all electrical cables, then cutting off from the tape coil.

4. METHOD OF MEASUREMENT -

4.1 Steel Cable of the SIZE specified shall be measured by the LINEAR FOOT (METRE) of material as actually placed, which shall include cable supports, clamps, insulators, and all other miscellaneous hardware and fittings.

4.2 Steel Cable used for back guying, is included under FURNISH AND INSTALL BACK GUY.

5. BASIS OF PAYMENT -

Accepted quantities of Steel Cable, measured as stated above will be paid for at the contract unit price bid for:

For span wire:

3/8 INCH (9.53 MM) GALV. STEEL CABLE -- LINEAR FOOT (METRE)

For bottom tether cable or as messenger:

1/4 INCH (6.35 MM) GALV. STEEL CABLE -- LINEAR FOOT (METRE)

(or other sizes as shown on the plans), and such payment shall be full compensation for furnishing and placing the cable, support rings, clamps, S-hooks, turnbuckles, and other incidentals required to complete the work as specified.

FURNISH AND INSTALL CONTROLLERS AND 332/336 CABINETS**Description**

This item consists of installing and or/ furnishing Model 2070L Standard, digital, solid-state, micro-processor based, keyboard (push-button) programmable, Master/Local Controllers in: (1) POLE-, or (2) BASE- MOUNTED 332 or 336 Cabinets, in accordance with these Specifications, at the locations shown on the Plans, or directed by the DES. This item shall include all electrical accessories and other items specified.

The phasing of the Controller and Cabinet shall be factory wired or wired by the CONTRACTOR or Manufacturer's Representative, to match (at each intersection) the Phasing Diagram, the Sequence of Operation form, or the Plans.

(1) Materials**1. ITEMS****a) List**

The equipment specified herein consists of the following:

- **Item A1** - Model 2070L Controller
- **Item A2** - Model 2010 ECL-IP Conflict Monitor
- **Item A3** - Model 332A Cabinet Assembly
- **Item A4** - Model 336S Cabinet Assembly
- **Item A5** - Model 332 Cabinet
- **Item A6** - Model 200 Load Switch
- **Item A7** - Model 204 Flasher
- **Item A8** - Rack Mount, LCD Enhanced/Intelligent Loop Detector
- **Item A9** - Model 222 Loop Detector
- **Item A10** - Model 242 DC Isolator
- **Item A11** - Model 430 Flash Transfer Relay
- **Item A12** - Suitcase Tester for 170/2070 Controllers
- **Item A13** - Automatic 210N AND 2010 ECL Conflict Monitor Tester
- **Item A14** - Aluminum Extender Base for 336S Cabinet
- **Item A15** - Replacement Red Enable board for 332A and 336S Cabinet Assemblies
- **Item A16** - Replacement #3 Lock and key set for all Cabinet Assemblies
- **Item A17** - Model 2070-7A, Asynchronous Serial Comm Module
- **Item A18** - External Fiber Optic Modem
- **Item A19** - External Dial-up Modem
- **Item A20** - Cabinet Assembly Display Unit
- **Item A21** - Model 206 Switching Cabinet Power Supply
- **Item A22** - Surge Protection for Twisted-Pair Communication

Items A1 – A22 will establish “Unit Prices” for present and future purchases.

b) Item definitions:

- **Item A3** (332A Cabinet Assembly) - A complete operating Cabinet Assembly containing the standard CALTRANS equipment complement with/including (<http://www.dot.ca.gov/hq/traffops/elecsys/TEES.htm>)

ONE (1) of **Item A2**, plus TWELVE (12) of **Item A6** (Load Switch), TWO (2) of **Item A10** (DC Isolator), SIX (6) of **Item A11** (Flash Transfer Relay), TWO (2) of **Item A7** (Flasher) and EIGHT (8) of **Item A8** (LCD Enhanced/Intelligent Loop Detector) and ONE (1) of **Item A22** (Surge Protection for Twisted-Pair Communication). **The 332A Cabinet Assembly shall NOT include a 2070L Controller.**

- **Item A4** (336S Cabinet Assembly) - A complete operating Cabinet Assembly containing the standard CALTRANS equipment complement with/including:

ONE (1) of **Item A2**, plus EIGHT (8) of **Item A6** (Load Switch), TWO (2) of **Item A10** (DC Isolator), FOUR (4) of **Item A11** (Flash Transfer Relay), TWO (2) of **Item A7** (Flasher) and FOUR (4) of **Item A8** (LCD Enhanced/Intelligent Loop Detector) and ONE (1) of **Item A22** (Surge Protection for Twisted-Pair Communication). **The 336S Cabinet Assembly shall NOT include a 2070L Controller.**

2. SPECIFICATIONS

a) *General* –

The equipment to be furnished shall be in accordance with CALTRANS Transportation Electrical Equipment Specifications (TEES), dated July 21, 2008 except as required herein. Equipment furnished shall also be approved as stated on the current South Carolina Department of Transportation Qualified Products List.

Further, the equipment shall meet the special Department requirements, as stated in the following Specifications. In case of conflict, the Department Specifications shall govern.

3. SPECIAL PROVISIONS

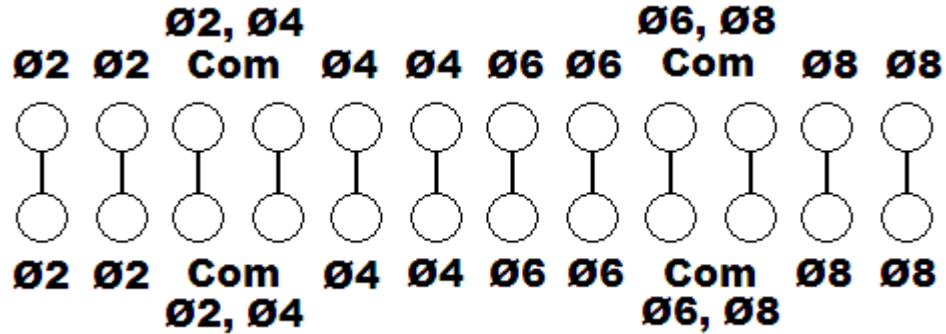
In addition to meeting the CALTRANS specifications as stated in section 2.1, all equipment shall also meet the following:

- Nylon card-guides shall be integrated into the cabinet assemblies where all Load Switch, Flasher and Input File Hardware may be installed. The card guide slots shall be of sufficient depth to support pluggable devices when they are not fully inserted into the electrical receptacles, and the installation or removal of pluggable devices shall not require excessive force.
- Raise AC Service terminal block to a minimum of 6" from base of the rack-supports in all Cabinet Assemblies.
- Install an aluminum plate for reinforcement of the pole-mounting brackets. This plate shall be installed inside the 336S Cabinet Assembly and shall utilize threaded PEM nuts or self-clinching fasteners for simple installation and removal of exterior pole-mount bracket bolts without the use of any tool, inside the Cabinet Assembly.
- Install (4) support braces for the rack assembly. Braces shall be welded, with a continuous seam and (2) shall be installed on each side, symmetrically centered from front to back, between the rack assembly uprights.
- To prevent accidental, electrical contact between the Cabinet Assembly and Conflict Monitor Unit, the entire side panel within the output file that is directly adjacent to the solder-side of the Conflict Monitor Unit shall be insulated with non-conductive sheeting. This sheeting shall not degrade over time and shall remain attached to the output file throughout the life of the Cabinet Assembly. This sheeting shall be of minimal thickness as to not impede the insertion and/or removal of the Conflict Monitor Unit.
- Red enable board shall implement individual, 2-position dipswitches allowing any unused red channel to be tied to AC+.
- The Red Enable board shall be easily removable and replaceable from the outside of the Output File Assembly. Removal and replacement shall not require the Output File Assembly to be opened. The design shall be such that the board can be easily unplugged and replaced. During normal operation the board shall be secured to the Output File Assembly.
- The Output File Assembly shall implement a hinged, clear, plastic cover to protect the Red Enable Board during normal operation. This cover shall be hinged on the left or

right side. When closed, the side opposite the hinge shall be secured to the Output File Assembly without the use of any hardware or tool. When fully opened, the cover shall not inhibit the removal, replacement or configuration of the Red Enable board. Removal/replacement of the Red Enable Board shall not require the removal of the protective cover.

- The Power Supply furnished in all 332A and 336S Cabinet Assemblies shall be the EDI 206L Switching Power Supply, or approved equivalent.
- The Cabinet Assemblies shall be provided with a means of securing the Model 206L Power Supply into place during normal operation and shall prevent the Power Supply from being removed unintentionally. The method used must be strong enough to support the weight of the power supply, shall be accessible from the FRONT of the Cabinet Assembly and shall not modify the Power Supply in any way. The insertion or removal of the Cabinet Power Supply shall not require the use of any tool.
- All Cabinet Assemblies shall have BOTH doors ventilated and are to include disposable filters that are secured in place, yet easily removed or re-installed for replacement.
- For any existing on-street twisted-pair communication, an EDCO PC642 surge protection device and applicable 170-style cabling shall be included in 332A and 336S Cabinet Assemblies.
- Front and rear doors of all cabinet assemblies shall implement a #3 Corbin Locking assembly. Two (2) BRASS keys are to be included with each Cabinet Assembly.
- The front and rear door locks for all Cabinet Assemblies shall have a minimum of 1 mm (0.03937") clearance between the edge of each side of the lock bolt and the cabinet's latch cam assembly.
- Front and rear door handles for all cabinet assemblies shall turn away from the door lock/key to open the cabinet door.
- Furnish 2 sets of non-fading cabinet diagrams and schematics that are to be placed in a clear, sealable, water tight, plastic bag and stored within the front-door-mounted laptop shelf/storage compartment. See Section 3.1.3 "Laptop Shelf" for additional requirements.
- The Flash Sense/Stop Time terminations in the Input File Assembly shall be wired such that a DC Isolator will not be required for implementation of these functions by the Conflict Monitor Unit.
- Furnish (2) Model 242 DC Isolators with all 332A and 336S Cabinet assemblies. These items are to be installed within the cabinet input file, in the pedestrian input slots.
- Furnish (8) Enhanced LCD Loop Detectors with all 332A Cabinet Assemblies. These are to be installed in the first (8) slots of the upper input file assembly. See section 11.1 for LCD Detector requirements.
- Furnish (4) Enhanced LCD Loop Detectors with all 336S Cabinet Assemblies. These are to be installed in the first (4) slots of the input file assembly. See section 11.1 for LCD Detector requirements.
- Furnish (12) Model 200 Load Switches with all 332A Cabinet Assemblies. These are to be installed in the following output file channels: 1, 2, 4, 5, 6, 8, 13, 14, 15, 16, 17, 18. See section 7.1 for Load Switch requirements.
- Furnish (8) Model 200 Load Switches with all 336S Cabinet Assemblies. These are to be installed in the following output file channels: 2, 4, 6, 8, 13, 14, 15, 16. See section 7.1 for Load Switch requirements.
- Furnish (2) Model 204 Flashers with all 332A and 336S Cabinet Assemblies. These are to be installed in the flasher slots within the PDA. See section 8.1 for Flasher requirements.
- Load Switches and Flashers are to be secured within their respective slots for shipment, with ½" string-reinforced tape as a minimum.
- Furnish a Thermostat-controlled, dual-fan (100CFM minimum rating per fan) ventilation system in all 332 series Cabinet Assemblies.
- Furnish a Thermostat-controlled, single-fan (100CFM minimum rating) ventilation system in all 336S Cabinet Assemblies.
- Cabinet Thermostat to be factory-set to 90 degrees in all Cabinet Assemblies.

- Cabinet Thermostat and thermostat temperature setting shall be easily accessible and adjustable from the front of all Cabinet Assemblies.
- Cabinet Thermostat terminals shall be insulated to prevent accidental electric shock.
- Police panel door shall be insulated to prevent water from entering the cabinet assembly. The insulation material used and its ability to resist water-penetration shall not degrade over time.
- The Police panel assembly shall have a drain to prevent water from collecting within the assembly. Per CALTRANS, the drain shall be channeled to the outside of the cabinet.
- The protective cover for the police panel key opening shall be snug with the police panel door and shall not move freely. However, this protective cover shall be easily opened without having to use any tool.
- Manual Control cord shall be permanently hard-wired into the Police panel assembly to prevent removal.
- Manual Cord shall be anchored to the inside of the cabinet chassis to prevent over-extension and/or damage to the Police Panel terminations when the cord is extended for use.
- For storage, the Manual Control cord should be fed into the cabinet assembly through a grommet opening at the top of the police panel. The location of the opening shall not allow water to enter the cabinet. Additionally, the cord shall be fed for storage into an area where there is no risk of 'snagging' the cable when it is extended for use.
- For additional security, a quick-connect/quick-disconnect, molex-style connector shall be used for the Police Panel wiring inside the Cabinet Assembly. This connector shall NOT be accessible from the Police Panel and should be easily accessible from inside the cabinet. The wiring of this connector shall be such that, when disconnected, the Manual Control Enable/Advance Enable function on the Police Panel, as well as the Interval Advance/Advance function on the manual cord cannot be applied to the Controller Unit.
- The Police panel shall be wired such that the Interval Advance/Advance function cannot be applied to the Controller Unit when the Manual/Auto switch is in the Auto position.
- The Cabinet Assembly Surge Protection device shall be the EDCO SHA-1250 with the SHA-1250-BASE-A (or approved plug-in equivalent). The Surge Protection device shall be easily accessible within the Cabinet Assembly.
- All Vehicle and Pedestrian terminals on the Loop Input Termination Panel shall be clearly labeled with permanent screening, with the default CALTRANS phase assignment, in all 332A and 336S Cabinet Assemblies.
- The 332A Cabinet Assembly shall include additional terminations for Pedestrian Pushbutton inputs. These are to be wired in parallel with the standard input file terminations and surge protection. A Minimum of 24 extra terminals (12-position, dual-bus terminal strip) shall be provided, allowing 16 additional termination points for 4 Pedestrian Phases. The remaining 8 termination points shall be for the shared or "common" input for the adjacent Pedestrian Phase terminations. This termination panel shall be easily accessible, clearly labeled with permanent screening and may be placed in any available space on the side panel containing the standard Loop and Pedestrian input terminations. The required configuration is shown here:



- The 332A and 336S Cabinet Assemblies shall have a ‘Detector Test Panel’ installed above the Controller Unit. The panel shall be installed within the rack assembly and will have (8) 3-position mini-toggle switches, symmetrically spaced and horizontally arranged for placing calls to the Controller Unit. 3-position On-Off-On switches shall activate inputs. Upward motion of the switch shall lock into place and shall place a vehicle call to the Controller Unit until the switch is manually returned to center position. The center position of the switch shall not inhibit normal detector operation. Downward motion of the switch shall place a momentary closure vehicle call and will allow the intersection to resume normal detector operation when released. This panel shall be clearly labeled with permanent screening beneath each switch. The labeling shall identify each detector switch and default phase assignment for phases 1 through 8. The panel should also be titled “Vehicle Call Panel” and shall include a legend for switch operation: “On, Auto, Pulse”. The panel shall be wired as follows:

336S Cabinet		332A cabinet	
Detector Switches	Terminal	Detector Switches	Terminal
Phase 1	I1-F	Phase 1	I1-W
Phase 2	I2-F	Phase 2	I4-W
Phase 3	I3-F	Phase 3	I5-W
Phase 4	I4-F	Phase 4	I8-W
Phase 5	I5-F	Phase 5	J1-W
Phase 6	I6-F	Phase 6	J4-W
Phase 7	I7-F	Phase 7	J5-W
Phase 8	I8-F	Phase 8	J8-W

4. Related Specification And Standards -

All equipment furnished shall conform to these Specifications. Further, equipment shall conform to the applicable requirements of Underwriter's Laboratory Incorporated (UL); the Electronic Industries Association (EIA); the National Electric Code (NEC); the American Society for Testing and Materials (ASTM); the American National Standards Institute (ANSI); and other applicable standards and specifications.

DEPARTMENT REQUIREMENTS

This section specifies Department specific requirements that extend or modify the CALTRANS Specification.

5. CABINET REQUIREMENTS -

a) Mounting

Each 336S Cabinet shall be supplied with a removable base plate. Two (2) POLE mounting brackets shall be attached to each 336S cabinet. See Section 2.2 “Special Provisions” for additional requirements.

For 336S and 332A Cabinet Assemblies, the BASE mounting anchor-bolt pattern shall be as

specified in the CALTRANS Specifications.

Aluminum Extender Base for 336S Cabinets - (Item A14) For 336S cabinets, an 8", aluminum extender base shall be available, manufactured in the shape and dimensions that match the shape, dimensions and bolt-pattern of a 336S Cabinet Assembly. This item shall be ordered at Department option. The appropriate stainless steel hardware (nuts, bolts and washers) shall be included with each extender base to sufficiently mount the base to the 336S Cabinet Assembly.

b) *Police Button*

Each 332A and 336S Cabinet Assembly shall be provided with a manual police push button on an insulated cord allowing the operator to stand a minimum of 6' from the Cabinet Assembly, permanently mounted in conjunction with a manual/auto switch. When placed in the manual position, Manual Control Enable or Advance Enable shall be applied to the Controller, and Minimum Recall shall be applied to all used phases. Activation of the push button shall apply the Interval Advance or Advance input to the Controller Unit. Manual advancement will be prohibited in the minimum green, and clearance timing intervals. See Section 2.2 "Special Provisions" for additional requirements.

c) *Laptop Shelf*

For all 332, 332A and 336S Cabinet Assemblies, a hinged, aluminum shelf and integrated storage compartment shall be installed on the front door, inside the Cabinet Assembly. To allow better ventilation throughout the cabinet and rack, a sliding shelf/drawer within the rack assembly will not be permitted. The shelf shall have a smooth, non-slip surface, sufficient for use as a writing platform and of sufficient size and rigidity to support a typical laptop computer when extended for use. This shelf shall have rounded or insulated edges that do not have the potential to physically harm the user. The shelf shall lock into place when folded for storage. Locking the shelf for storage and/or extending for use shall not require the use of any tool.

d) *Loads*

"Ped-Yellows" shall be provided with "dummy loads" consisting of load resistors rated at 5 watts minimum. The impedance of the load resistors shall be such that the Conflict Monitor Unit does NOT see a false indication for the yellow output of the pedestrian channels.

e) *Lights*

Each Cabinet shall include Two (2) Fluorescent Lighting Fixtures. One mounted inside the top-front portion of the Cabinet and one mounted inside the top-rear portion of the cabinet. Both fixtures shall include a 15-watt, white fluorescent light bulb and shall include an easily accessible on-off switch. Door-actuated switches shall be installed to turn on the cabinet lights when either the front or rear door are opened. Light bulbs, or light fixture covers shall be secured in place for shipment via 1/2" string tape.

6. SURGE PROTECTION

General – Each 336S and 332A Cabinet shall be provided with devices to protect the control equipment from surges and over voltages. This shall include incoming power lines, the Input File, the Output File (load switch-packs), and communication lines. The surge protection for the Input File shall be in accordance with the assignment of the slots of a standard 336S Cabinet assembly. Surge protector termination panels shall be provided, attached to the Cabinet rack assembly. AC isolation terminals shall be on the same side of the Cabinet as the AC service inputs. DC terminals and loop detector terminals shall be installed on the opposite side of the Cabinet from the AC power lines, to reduce electromagnetic induction. The surge protector panels shall be designed to allow for adequate space for a wire connection and surge protector replacement. Surge protection shall be provided for the full capacity of the Cabinet Input File.

Intent of Surge Protection – It is the intent of the Department to require surge protection on each CALTRANS defined input; that is, full protection. For example, on the 336S Cabinet, Vehicle Loop Detector Surge Protection would be required on two (2) channels each, of Slots 1 to 8 of the Input File. In addition, on the remaining Slots 9 to 14, Pedestrian surge protection; plus Auxiliary (pre-emption) protection as defined.

On the 332A Cabinet, full protection is desired on both Input Files. For example, Vehicle Loop Detector Surge Protection would be required on two (2) channels each, of Slots 1 to 8 of BOTH INPUT FILES I AND J; together with pedestrian and auxiliary protection on both racks.

For the 332A Cabinet, appropriate input surge protection shall be mounted on the INPUT TERMINATION PANEL. For the 336S Cabinet, appropriate input surge protection shall be mounted on a FOLD-DOWN TERMINATION PANEL on the rear of the cabinet assembly. This fold-down panel shall not obstruct the Output File Field wiring when in the closed position and shall utilize thumb-screws to secure the panel under normal operating conditions.

Under no circumstance (normal operation or short-circuit condition) shall the ampacity of the internal wiring and printed circuit board traces be less than the protecting threshold of circuit breakers and surge protectors provided.

Power Distribution Assembly - The Power Distribution Assembly of each Controller Cabinet shall include a lightning/surge/transient protection unit on the AC Service Input. It shall be capable of reducing the effect of lightning transient voltages applied to the AC line. The protector shall be a two-stage series/parallel device, and shall be an EDCO SHA-1250 (or approved equal). It shall have the following features and functions:

- Maximum AC line voltage: 140 VAC
- Twenty pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20,000 Amperes
- The protector shall be provided with the following terminals:
 - Main line (AC Line first stage terminal)
 - Main Neutral (AC Neutral input terminals)
 - Equipment Line Out (AC Line second stage output terminal, 10 Amps).
 - Equipment Neutral Out (Neutral terminal to protected equipment).
 - Ground (Earth connection)
- The Main AC line in and the Equipment Line out terminals shall be separated by a 200 Micro Henry (minimum) inductor rated to handle 10 Amp AC Service.
- The first stage clamp shall be between Main Line and Ground terminals.
- The second stage clamp shall be between Equipment Line Out and Equipment Neutral.
- The protector for the first and second stage clamp shall have a MOV or similar solid-state device rated at 20 KA; and be of a completely solid stage design (i.e. no gas discharge tubes allowed).
- The Main Neutral and Equipment Neutral Output shall be connected together internally, and shall have an MOV (or similar solid state device, or gas discharge tubes) rated at 20 KA between Main Neutral and Ground terminals.
- Peak clamp voltage: 250 Volts at 20 KA. (Voltage measured between Equipment Line Out and Equipment Neutral Out terminals. Current applied between Main Line and Ground Terminals with Ground and Main Neutral terminals externally tied together).
- Output voltage shall never exceed 280 volts.
- The Protector shall be epoxy-encapsulated in a flame retardant material.
- Continuous service current; 10 Amps at 120 VAC RMS.

- The Equipment Line Out shall provide power to the Type 170 Controller, and to the 24 V power supply.

Inductive Loop Detector Inputs - Each inductive loop detector input channel shall be protected by an external surge protection device which shall be an EDCO SRA-6LC (or approved equal) meeting or exceeding the following requirements:

- It shall be a three-terminal device, two of which shall be connected across the signal inputs of the detector. The third terminal shall be connected to chassis ground to protect against common mode damage.
- It shall instantly clamp differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array shall be designed to appear as a very low capacitance to the detector.
- It shall clamp common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.
- It shall meet or exceed the following requirements:

Peak Surge Current (six times)	
Differential Mode	400 Amps (8x20 μ s)
Common Mode	1000 Amps (8x20 μ s)
Estimated Occurrences	500 @ 200 Amps
Response Time	40 ns
Input Capacitance	35 pf typical
Temperature	-40 degrees to +85 °C
Mounting	No. 10-32 x 3/8" bolt
Clamp Voltage	
@400 Amps Diff. Mode	30 volts max.
@1000 Amps Comm. Mode	30 volts max.

Signal Load Switches (Switch-Packs) - The outputs of each switch-pack in the output file shall be provided with a Metal Oxide Varistor (MOV), which is connected from the AC positive field terminal, to the chassis ground. The MOV shall be rated 150VAC, and shall be a V150LA20A.

Communication Inputs – Each low voltage communication input shall be protected as it enters the cabinet with a surge protection unit which shall be an EDCO PC-642C-30-X (or approved equal), that meets or exceeds the following requirements:

- It shall be a dual pair (four wire) module with a printed circuit board connector, double-sided and gold-plated for reliability.
- It shall mate and be installed in a ten (10) circuit Buchanan connector PN PCB1B-10A or equivalent.
- It shall be utilized as two independent signal pairs. The data circuits shall pass through the protection in a serial fashion. It shall be a hybrid two-stage unit.
- It shall meet the following minimum requirements:

Peak Surge Current	10K amps (8x20 μ s, wave shape)
Occurrences at 2000 Amps	>100
Response Time	<1nanosecond
Voltage Clamp	30
Series Resistance	➤ 15 Ohms per line
Temperature	-40 degrees to +85 degrees C

Primary Protector	Three element gas tube 10KA, 8x20 µs per side
Secondary Protector	Rugged solid state clamps, 1.5 KW minimum

- The line side shall be connected to the Communication field wires.
- The load side shall be connected to the C2 connector of the 170 Controller or the 2070-6B Comm Module of the 2070 Controller.
- The ground terminal shall be connected to chassis ground.

Low Voltage DC Inputs - Each DC Input channel shall be protected by an external surge protection device, which shall be an EDCO SRA64-030N (or approved equal), that meets or exceeds the following:

- It shall be a five terminal device. Two terminals shall be connected to the line side of the low voltage pair, two terminals shall be connected to the Input File side, and the fifth terminal shall be connected to chassis ground.
- It shall meet the following minimum requirements:

Peak Surge Current	2000 Amps 8x20 µs Wave-shape
Occurrences at Peak Current	100 typical
Response Time	5 to 30 nanoseconds
Shock	Withstands 10-foot drop on concrete
Voltage Clamp	30 v
Series Resistance	15 ohms each conductor
Temperature	-20 Degrees to +85 °C

Pre-Emption & 115 VAC Signaling Inputs - Each pre-emption or AC signaling input channel shall be protected by an external surge protection device, which shall be an EDCO SPA-60BS-2 (or approved equal), that meets or exceeds the following:

- It shall be a three terminal device.
- It shall meet the following minimum requirements:

Peak Surge Current	2000 Amps 8x20 µs Wave-shape
Occurrences at Peak Current	25 minimum
Response Time	< 200 nanoseconds
Shock	Withstands 10-foot drop on concrete
Peak Surge Trip Point	< 890 V nominal
Temperature	-40 Degrees to +85 °C

7. CABINETS

The Department will utilize the Cabinets listed below.

a) **Model 336S Cabinet Assembly - (Item A4) (46" x 24" x 22") -**

The Model 336S Cabinet Assembly shall be as specified in the CALTRANS Specifications. The Cabinet shall be capable of side-pole mounting, as well as base mounting. See Section 2.2 "Special Provisions" for additional requirements.

The 336S Cabinet shall incorporate input surge protection mounted on a FOLD-DOWN TERMINATION PANEL at the rear of the Cabinet Assembly. This fold-down panel shall not obstruct the Output File Field wiring when in the closed position and shall utilize thumb-screws to secure the panel under normal operating conditions. The fold-down portion of this panel shall be easily

accessible and shall be mounted to the rack assembly.

The 336S Cabinet shall NOT have an AUXILIARY OUTPUT FILE. Additionally, Auxiliary Output files will not be added to a 336S Cabinet Assembly, therefore the additional wiring necessary to add an Auxiliary Output file shall not be installed. All assemblies in the 336S Cabinets shall be installed in the upper most position so that free space at the bottom of the cabinet is maximized.

b) Model 332A Cabinet Assembly - (Item A3) (66" x 24" x 30") -

The Model 332A Cabinet Assembly shall be as specified in the CALTRANS Specifications. This Cabinet shall incorporate an INPUT TERMINATION PANEL. See Section 2.2 "Special Provisions" for additional Pedestrian Pushbutton Termination requirements. The Cabinet shall be base mounted.

The 332A Cabinet Assembly shall be configured for 8 vehicle phases, 4 pedestrian phases and shall include an AUXILIARY MODEL 420 OUTPUT FILE, for 6 overlap phases.

c) Model 332 Cabinet - (Item A5) (66" x 24" x 30") -

The Model 332 Cabinet shall be base mounted and shall contain a standard rack assembly for the future installation of various ITS components. The cabinet shall meet all aspects of the physical and structural requirements stated in Section 2.2 "Special Provisions".

The following shall be installed:

A 3-terminal, 50-Amp AC Service bus shall be installed as well as a Thermostat and dual-fan ventilation system with two (2) cabinet filters. Two (2) Fluorescent light fixtures with front and rear door-activated switches shall also be installed.

The thermostat, fans and lights shall be appropriately wired. The service side of the AC+ and AC Neutral wires for this equipment shall be neatly dressed and brought down the full length of the side-panel of the Cabinet Assembly for DOT personnel to terminate at a later time.

This Cabinet may be used by the Department for future projects such as ramp metering, sign control, speed detection, or freeway surveillance.

8. CONTROLLER UNIT – (Item A1)

Furnish Model 2070L Controllers. Units shall conform to CALTRANS Transportation Electrical Equipment Specifications (TEES), dated July 21, 2008 except as required herein. Units shall also be approved as stated on the current SCDOT "Qualified Products List". Provide model 2070L Controllers composed of the unit chassis and at a minimum, the following modules, assemblies, and software:

- Model 2070-4B Power Supply Module, 3 AMP
- Model 2070-3B Front Panel Module
- Model 2070 1B CPU Module, single board
- Model 2070-2A Field I/O Module
- Model 2070-7A Asynchronous Serial Com Module
- Controller Software – Provide model 2070L with the software compatible with the controller. Both controller and software must be on SCDOT "Qualified Products List" at the time of the work order. The installed controller will be selected for particular work orders at the discretion of the Traffic Signals and Systems Engineer based on compatibility with the central software.

9. POWER DISTRIBUTION ASSEMBLY 2

Assembly - The Power Distribution Assembly shall be as specified in the CALTRANS Specifications for Assembly 2, and modified as follows. The Assembly shall include an EDI Model 206L Switching Power Supply as stated in Section 2.2 "Special Provisions".

Protection - It shall include over-voltage protection as described in the paragraph "SURGE PROTECTION" (EDCO SHA-1250 or approved equivalent). See Section 2.2 "Special Provisions" for

additional requirements.

10. MODEL 200 LOAD SWITCH – (Item A6)

The Load Switch shall be a PDC MODEL SSS-88 LOAD SWITCH, meeting or exceeding the CALTRANS Specifications.

11. MODEL 204 FLASHER – (Item A7)

The flasher module shall be a PDC MODEL SSF-88 FLASHER, meeting or exceeding the CALTRANS Specifications.

12. MODEL 2010 ECL-IP CONFLICT MONITOR - WITH ABSENCE OF RED MONITORING – (Item A2)

The Conflict Monitor shall be an EDI Model 2010 ECL-IP Conflict Monitor.

The Conflict Monitor Unit shall contain a 10/100 Ethernet port on the front panel for the uploading of alarms and/or event logs with a standard laptop computer. This port shall also allow for future communication within an Ethernet-based infrastructure.

Red Monitor Harness - A connector and terminal assembly designated as P20 (Magnum P/N722120 or equivalent), for monitoring the absence of red, shall be an integral part of the output file. The connector shall terminate, and be compatible with, the cable and connector of a Type 170 Conflict Monitor unit (CMU), capable of monitoring the absence of red.

The P20 cable shall be routed internally or between the rack assembly and cabinet wall. The cable shall be anchored to the front of the output file so that the Conflict Monitor Unit cannot be removed with the cable attached. The pin assignments of the P20 connector and terminal assembly shall be provided with the Cabinet plans. The P20 connection shall be physically “keyed” to prevent the cable from being installed incorrectly.

Programming of Unused Red Channels - All Cabinet assemblies shall be provided with a means of applying AC+ to unused red channels by the configuration of dipswitches on the Red Enable board. The Red Enable board in all Cabinet Assemblies shall have full compatibility with model 210N and 2010ECL Conflict Monitor Units. See Section 2.2 “Special Provisions” for additional requirements.

13. MODEL 222 LOOP DETECTOR AMPLIFIERS – (Item A9)

Type -The Loop Detector Amplifier Unit shall be an EDI MODEL 222 (or equivalent) as specified in the CALTRANS Specifications. The detector shall be two (2) channels. The Detector shall perform properly when installed in new or existing Cabinet Assemblies in SC.

14. LCD ENHANCED/INTELLIGENT LOOP DETECTOR AMPLIFIER – (Item A8)

Type - The Loop Detector Amplifier Unit shall be an EDI Oracle or Reno A&E Model C Rack Mount Detector Amplifier or approved equivalent. The Detector shall perform properly when installed in new or existing Cabinet Assemblies in South Carolina.

15. MODEL 242 D.C. ISOLATOR – (Item A10)

The D. C. Isolator unit shall be a MODEL 242 as specified in the CALTRANS Specifications.

16. MODEL 430 FLASH TRANSFER RELAY – (Item A11)

The Flash Transfer Relay unit shall a MODEL 430 as specified in the CALTRANS Specifications.

17. DIAGNOSTIC TEST PROGRAM -

Controller Test - This item shall consist of a Diagnostic Test Program, having features, to test the operation of a Model 2070L Controller unit, including but not limited to: internal memory, the real-time clock, input-output circuitry, the display, display backlight and the keyboard.

Cabinet Test - A Diagnostic Test Program shall verify the operation of Cabinets furnished under this bid. The Program shall test Cabinet wiring related to the Output file, Input File, Conflict Monitor, Police panel, and Flash switches. This test may be provided on a set of EPROMS for use in a 170E Controller.

BIDS SHALL PROVIDE full documentation on the supplied test programs, their operation, and features. It shall be possible to send output reports to an external printer, or to a file on an IBM Compatible Personal Computer. Any third party PC software necessary shall be clearly stated and named.

18. SUITCASE TESTER (FOR 170/2070 CONTROLLERS) – (Item A12)

Option - This item shall be ordered at Department option.

General - This shall be a stand-alone portable tester, mounted in a sturdy suitcase/briefcase, of size large enough to hold cables and manuals. An intersection mockup display shall be incorporated on the top half. LED indicators shall be used on all applicable outputs, in the appropriate color, at the appropriate intersection location. Indications include all channels for eight (8) vehicle phases and four (4) pedestrian phases. The unit shall also have additional indications for six (6) auxiliary vehicle overlaps and four (4) pedestrian yellow channels as well as 'watch dog' and 'detector reset' indications. Three (3) position On-Off-On switches shall activate inputs. The downward motion of the switch shall be a momentary closure. All outputs/indications shall be appropriately labeled by function and all inputs shall be labeled by the applicable C-1 and/or C-11 pin number.

19. AUTOMATIC TESTER (FOR 210N AND 2010ECL CONFLICT MONITORS) – (Item A13)

Option - This item shall be ordered at Department option.

General - shall be a stand-alone portable "Tester", intended for use on a workbench. The Tester may utilize an IBM compatible computer for input/output. The Tester shall test Conflict Monitor displays; timing and voltage functions; input/output combinations for true or false conflicts. Any software shall be modular, menu driven, and offer "help" screens as well as having compatibility with SCDOT's Current Windows XP Professional Software. A video "setup/usage" training tape shall be provided with each unit. All input/outputs shall be in plain English. It shall be possible to generate a hardcopy printout, or to store the results to a disk file. A "No Faults Detected" report shall be displayed as appropriate.

20. MODEL 2070-7A, ASYNCHRONOUS SERIAL COMM MODULE – (Item A17)

Option -This item shall be ordered at Department option. It will be used in addition to the 2070-7A Module furnished with each 2070L Controller at Field Master and/or Local Intersections requiring an additional Serial Port.

Unit - Units shall conform to CALTRANS *Transportation Electrical Equipment Specifications* (TEES), dated July 21, 2008 except as required herein.

21. EXTERNAL FIBER OPTIC MODEM – (Item A18)

Option -This item shall be ordered at Department option. It will be used at 2070L Master and/or Local Controllers requiring Fiber Optic Communication within a Closed-Loop System.

Unit - The modem used for this contract shall be the Traffic Fiber Systems Model FO-512 Fiber Optic Data Link or approved equivalent. The modem shall be furnished with a power supply

AND RS-232 cable.

The RS-232 cable used for this contract shall provide a fully functional, full-duplex communication link between a Serial Port on the 2070-7A Comm Module and the supplied Fiber Optic Modem. The cable shall be a minimum of 3' in length. The connectors shall include a protective shell and must utilize two (2) industry-standard thumb-screws to secure the cable in place at both ends without having to use any tool. The connector assembly shall also be manufactured in such a way that the connecting cable and connector are secured to prevent unintentional electrical and/or physical separation. The cable shall have connections with the proper gender on each end (without the use of gender adapters) and shall be clearly labeled.

22. EXTERNAL DIAL-UP MODEM – (Item A19)

Option -This item shall be ordered at Department option. It will be used in either the Central Office, or at a Field Master or Local Intersection requiring dial-up access.

Unit- The dial-up modem used for this contract shall be the US Robotics V.92 External Modem. The modem shall be furnished with a power supply, telephone cable AND RS-232 Cable.

The RS-232 cable used for this contract shall provide a fully functional, full-duplex communication link between a Serial Port on the 2070-7A Comm Module and a US Robotics V.92 External Modem for telecommunications. The cable shall be a minimum of 3' in length. The connectors shall include a protective shell and must utilize two (2) industry-standard thumb-screws to secure the cable in place at both ends without having to use any tool. The connector assembly shall also be manufactured in such a way that the connecting cable and connector are secured to prevent unintentional electrical and/or physical separation. The cable shall have connections with the proper gender on each end (without the use of gender adapters) and shall be clearly labeled.

23. CABINET ASSEMBLY DISPLAY UNIT – (Item A20)

Option -This item shall be ordered at Department option. It will be used by Technicians in SCDOT Signal Shops.

Unit - The unit required for this contract will be used by signal shop technicians during the set up and integration of 336S and 332A Cabinet Assemblies. Via permanent screening, the unit will display a mock-up of a quad intersection with left turns and shall implement appropriately arranged and colored AC-driven LED indications (P/N: LED-120PSB or equivalent) of all channels for eight (8) vehicle phases and four (4) pedestrian phases. The unit shall also have additional indications for six (6) auxiliary vehicle overlaps and four (4) pedestrian yellow channels. The display unit shall include a removable harness that is a minimum of 6' in length, with black, 22-gauge termination wires for all indications as well as one (1) white, 22-gauge AC Neutral and one (1) green, 22-gauge Chassis Ground termination. All wires shall have #10 stud spade lugs installed and shall be labeled by phase and color.

The display unit shall provide proper load to accurately simulate on-street, AC signal terminations for testing purposes within a signal shop environment. This unit shall be designed so that it can be placed on top of the Cabinet Assembly, or hung on the inside of the front door of any Cabinet Assembly supplied for this contract.

24. MODEL 206L POWER SUPPLY – (Item A21)

Option -This item shall be ordered at Department option. It will potentially be used to upgrade existing standard Power Supply Units in the field.

Unit -The unit required for this contract shall be the EDI Model 206L Power Supply or approved equivalent. The Power Supply Unit shall incorporate switching design technologies as well as Power Factor Correction. See Section 2.2 "Special Provisions" for additional physical requirements.

25. REPLACEMENT RED ENABLE BOARD FOR 332A AND 336S CABINET ASSEMBLIES – (Item A15)

Option -This item shall be ordered at Department option. It will potentially be used to replace damaged or malfunctioning Red Enable boards within 332A and 336S Cabinet Assemblies supplied for this contract. Items furnished shall be identical to the red enable boards furnished with the 332A and 336S Cabinet Assemblies for this contract.

Unit -See Section 2.2 “Special Provisions” for additional requirements.

26. REPLACEMENT #3 LOCK AND KEY SET – (Item A16)

Option -This item shall be ordered at Department option. It will potentially be used to replace faulty or damaged lock assemblies in existing Cabinet Assemblies in the field as well as within cabinet Assemblies furnished for this contract.

Unit -See Section 2.2 “Special Provisions” for additional requirements.

27. SURGE PROTECTION FOR TWISTED-PAIR COMMUNICATION – (Item A22)

Protection – Surge protection for twisted-pair communication shall be included in all 332A and 336S Cabinet Assemblies. The surge protection device shall be an EDCO PC-642C-30-X (or approved equal). See Section 3.2.8 for additional requirements.

Cabling – Applicable 170-style cabling shall be included in all 332A and 336S Cabinet Assemblies.

28. Cabinet Foundations

Cabinet foundations will be either supplied by the SCDOT or will need to be built per specifications as directed by the DES.

a) Concrete

The Concrete provided shall be CLASS A, and shall be mixed, poured, and finished in accordance with SC DOT STANDARD SPECIFICATIONS, Section 701, 702, 703, and 704.

Base mounted Cabinets shall be installed on a properly formed foundation, as shown on the Design Details or the Standards.

b) Reinforcing Steel.

Steel reinforcement shall conform to the requirements of DOT STANDARD SPECIFICATIONS, Section 703.01, which is amended to include the following:

“All references to AASHTO M 31 or ASTM A 615 are hereby deleted and replaced by ASTM A 706 with a single minimum yield strength level of 60,000 psi, designated as Grade 60.”

The bars or wire shall be of the size and type shown on the Design Details or in the Standards.

c) Conduit Elbows

See FURNISH AND INSTALL ELECTRICAL CONDUIT. Shall be of the size and type shown on the Plans or the Design Details or Standards.

d) Ground Rod

Ground rods shall be 5/8 inch by 8 feet (minimum) Copper-clad. A No. 6 AWG bare, solid or stranded copper wire shall be used in the ground connection. A Base-mounted Cabinet requires a separate ground rod. A Pole-mounted Cabinet may use the ground rod associated with that pole.

e) Miscellaneous

All components or hardware shall be made of non-corrosive material, or be of the same materials as the item being installed.

NOTE: CATALOG CUTS ARE REQUIRED**(2) Training****1. Required**

Formal "hands-on" classroom-training sessions are required as a condition of this Contract.

Resume's and certifications for instructors and training agenda's are to be supplied to the Department for approval.

The training shall provide a personal "take-home" package of training materials/documentation for each student. Training shall be conducted for the (5) five separate schools in Department facilities at the same or, at the discretion of the Department at different locations. Training shall be scheduled to occur in one contiguous week, with not more than 6 hours of training in any one day. All training shall be held during the Department's normal working hours.

2. Complete Cabinets

The Vendor of "Complete Cabinet Assemblies" shall provide training in the design, operation, and maintenance of 2070 controllers and associated equipment; and of cabinet set-up and configuration.

The Vendor of Complete Cabinet Assemblies shall be prepared to present a minimum of 18 hours of classroom and "hands-on" training.

3. Individual Items

The Vendor of Individual Items shall be prepared to present 6 hours of classroom and hands-on training for individual bid Items. Details of this training shall be coordinated with the Department, and with other Vendors, including subject and materials required.

4. Required – (each complete session)

DAY 1: A maximum of 20 people, would receive "engineering related training", including: Introduction, Equipment description, Operation, and engineer controlled cabinet setup.

DAY 2, DAY 3: A maximum of 20 persons would receive "hands-on" training on maintenance and repair of all user serviceable equipment. Maintenance training shall include field level troubleshooting. This training shall be for a minimum duration of 2 days.

DAY 4, DAY 5: The group of 20 as above shall receive Training on Individual cabinet Items.

(3) Construction**1. Concrete Foundation**

The foundation shall be constructed to the dimensions shown on the Design Details or the Standards. Bolt "circle" data shall be in accordance with the recommendations of the Cabinet Manufacturer. Suitable templates for setting anchor bolts shall be accurately set, and left in place until the forms are removed. Concrete lag bolts drilled into pad are allowed.

Concrete shall be mixed, placed, and tested in accordance with applicable portions of SCDOT STANDARD SPECIFICATIONS Sections 701, 702, 703, and 704.

Base mount Cabinets shall be set in place on a bead of silicon caulk.

2. Ground Rod and Ground Wire

A ground rod and ground wire are to be furnished and installed with each Cabinet. The ground rods shall be 5/8 inch by 8 feet (minimum) Copper-clad and shall be placed near the cabinet's concrete foundation, external to the cabinet pad. It is preferable to install the ground rod in a junction box or splice box where possible. A 1 inch PVC conduit and elbow shall be placed in foundation prior to pouring as shown in the Design Details or the Standards. Ground wires (No. 6 AWG bare, stranded copper wire) shall run continuously from the ground rod to the Controller Cabinet (chassis ground on the AC ground bar) through this conduit; and shall run continuously from the ground rod to the foundation anchor bolts, to the conduit bends, etc. Ground wires shall be EXOTHERMICALLY WELDED TO THE GROUND ROD. Grounding bushings shall be used on metal conduit. For Cabinets mounted on strain poles, the grounding stud on the pole shall also be connected.

The entire ground rod shall be driven below the grade or place in a junction box.

3. Conduit Elbows

The conduit entering the cabinet cannot be encased in concrete. See standard detail.

Conduit Elbows shall be set in the footing excavation before the concrete is poured. The size and number shall be as shown on the Design Details or the Standards; OR shall be that necessary to mate the incoming runs. Conduit shall extend beyond the side of the finished foundation by approximately 12 inches, in the direction of, and at the depth of the incoming conduit. The conduit shall extend 3 to 6 inches above the top of the finished foundation, inside the pole or Cabinet.

The open-ends and threads on the conduit bends shall be covered and protected during construction activities.

4. Electrical Wiring

All required equipment shall be installed in the Cabinet, and neatly wired with harnesses that have been tied or wrapped. Force-fitted or mutually interfering equipment is not acceptable. Cable harnesses and terminals shall be legibly labeled. All bare wires should be terminated in a "spade-lug" prior to connection to a terminal strip. The "spade-lug" shall be crimped-on, using a ratchet-type crimping tool. Wires not facilitating equipment movement, should be tied to the back or side-panel. Equipment should be installed and positioned for easy access. Opening and closing the Cabinet door shall not chaff the wiring.

Field (lamp) wiring shall have 3 feet of slack cable in each cabinet. The slack shall be coiled and tied neatly in the bottom of the Cabinet. Signal cables shall be separated from detector lead-in cables as much as possible, to reduce interference.

(4) Measurement

Local Controllers and Cabinets installed will be measured by EACH TYPE Controller and Cabinet (mounting specified); and erected in place as shown on the Plans including miscellaneous electronics, load switches, wiring, electrical connection, ground rod, ground wire, and all related hardware.

(5) Payment

Installing and/or furnishing controller cabinet as measured above, will be paid for at the contract unit price.

INSTALL CONTROLLER AND 332/336 CABINET ASSEMBLY – POLE MOUNT – EACH
INSTALL CONTROLLER AND 332/336 CABINET ASSEMBLY– BASE MOUNT – EACH
FURNISH AND INSTALL CONTROLLER AND 332/336 CABINET ASSEMBLY – POLE MOUNT – EACH
FURNISH AND INSTALL CONTROLLER AND 332/336 CABINET ASSEMBLY– BASE MOUNT – EACH
FURNISH AND INSTALL 2070L CONTROLLER UNIT – EACH
TRAINING – LUMP SUM

Installing cabinet foundations shall be measured as follows and will be paid at the line item price:

FURNISH AND INSTALL CONCRETE CABINET FOUNDATION – EACH

Which shall be full compensation furnishing all materials, equipment, labor and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL REMOTE SPLICE/FLASHER CABINETS

DESCRIPTION - This work shall consist of installing and/or furnishing Splice Cabinets -or- Flasher Cabinets at remote locations and performing all related wiring necessary, in accordance with these Specifications. Many of the items necessary to create a complete installation are specified elsewhere. Among these are:

FURNISH AND INSTALL WOOD POLE;
 FURNISH AND INSTALL ELECTRICAL SERVICE;
 FURNISH AND INSTALL ELECTRICAL CONDUIT;
 FURNISH AND INSTALL COMMUNICATION CABLE; and
 FURNISH AND INSTALL ELECTRICAL CABLE.

A Splice/Flasher Cabinet will usually be located remote from the nearest signalized intersection.

1. MATERIALS -

1.1 Cabinet -

The Cabinet furnished shall meet the requirements stated in the Specification for "TRAFFIC SIGNAL CABINETS", TYPE 2, herein; with the specific features listed below:

A. Type. Aluminum; TYPE 2--The minimum approximate size shall be approximately 70 cm (27 in) High X 38 cm (15 in) Wide X 30 cm (12in) Deep.

B. Design. The Cabinet shall be designed for pole or pedestal-pole mounting. It shall be furnished with all related corrosion resistant hardware, including top and bottom mounting brackets, or pole-hub. Straps used shall be stainless steel.

C. Door. Hinged; full weather-tight gaskets; #2 rustproof cylinder lock with key.

D. Vent. Required.

E. Flasher Cabinet Features. Circuit breaker, 15 amp; radio-frequency line filter; lightning arrester; 120 VAC GFI duplex convenience outlet; fluorescent or incandescent lamp with switch; NEMA Standard 2-circuit Flasher, and other equipment necessary to complete the flasher installation. Plus terminal strips and grounding buss as necessary.

F. Splice Cabinet Features. The Cabinet shall have the number of terminal BLOCKS sufficient to connect the incoming and outgoing interconnection cables of ** pairs each; in accordance with the Manufacturers recommendations; plus terminal STRIPS for all grounds, commons, or other connections. Terminal Blocks shall be telephone quality, R66 "Quick-Connect M-type", having ** pairs capability, and use a "Stand-Off Mounting". All cables and terminals shall be clearly identified (labeled).

G. Schematic. There shall be furnished three (3) copies of the complete electrical schematic diagram for each Splice/Flasher Cabinet.

1.2 Conduit -

Conduit elbows, fittings, and risers shall meet the specifications stated in FURNISH AND INSTALL ELECTRICAL CONDUIT.

1.3 Miscellaneous -

All components or hardware shall be made of corrosion-resistant material, or be of the same materials as the item being installed.

2. **CONSTRUCTION METHODS** -

2.1 Mounting -

The Cabinet shall be mounted as shown in the Design Details or the Standards.

2.2 Wiring -

2.2.1 Electrical cables shall be connected to the terminals in accordance with the signal equipment Manufacturer recommendations. GROUNDING AND SURGE/LIGHTNING PROTECTION SHALL BE PROVIDED in every Splice Cabinet (unless specifically forbidden by the Manufacturer). The Protector shall be Telephone Company grade, and be conformable with the Terminal Block specified in Paragraph 1.1.F. When operated as part of a signal system, any additional protection required by *these* Manufacturers shall be included, with particular attention to On-Street Masters, Remote Communication Units, or connections to a Central Traffic Computer. The cable shield shall be grounded.

2.2.2 A No. 6 AWG bare stranded copper Ground Wire shall run continuously from the Cabinet to the ground rod at the pole base. Where design requires, a new ground rod shall be driven; and a ground wire installed from the Cabinet to the ground rod.

3. **METHOD OF MEASUREMENT** -

3.1 Furnishing and installing Remote Splice Cabinets or Flasher Cabinets, shall be measured by EACH housing, erected and placed as shown on the Plans, including miscellaneous electronics, electrical connections, etc. NOTE: The furnishing, installation, and payment of the conduit, poles, electrical service, and other major items are specified elsewhere.

4. **BASIS OF PAYMENT** -

4.1 Installing and/or furnishing remote Splice/Flasher Cabinets, accepted and measured as provided above, will be paid at the contract unit price bid for:

FURNISH AND INSTALL SPLICE CABINET / FLASHER CABINET - - EACH
INSTALL SPLICE CABINET / FLASHER CABINET - - EACH

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

FURNISH AND INSTALL "SYMBOLIC" LED BLANKOUT SIGNS

DESCRIPTION - This work shall consist of installing and/ or furnishing LED (Light Emitting Diode) NO RIGHT/LEFT TURN BLANKOUT SIGN, of CLAM-SHELL CONFIGURATION, with SUN VISOR and designated mounting hardware.

The blankout sign and the mounting hardware are stated as one item.

1. MATERIALS –

All sign housings shall be built to Institute of Transportation Engineers "Vehicular Traffic Control Signal Heads" (VTCSH) standards. All sign housings shall be furnished by the same manufacturer and shall be new and current production models. Blankout signs of the size, type, and arrangement specified, are to be furnished, together with ALL the necessary hardware for make-up and mounting. For the purpose of this Specification, the basic material requirements are listed below:

All blankout signs shall use an illumination of International Symbol consisting of a red circle and slash and either a white right arrow or white left arrow. When the display is not energized, the sign shall be effectively blank. The Symbol shall be illuminated by an assembly of high output lunar white and red LEDS.

The housing shall be constructed of Aluminum and shall be weatherproof. The outside dimensions shall not be less than 26 inches high by 26" wide and 8 inches deep. The housing shall not be less than .125 inch extruded aluminum with all corners being welded their full length. All welds shall use the tungsten inert gas method. A fitting shall be installed on the bottom of the sign in the middle for tethering. The back shall be aluminum of not less than .063 inches thick. The door shall be extruded aluminum of not less than .125 inch thickness and shall be welded on two corners and screwed together on the other two corners to provide access for installation of a faceplate and polycarbonate lens. The aluminum door shall be attached to the housing utilizing two (2) 'lift-off' type stainless steel hinges. The door shall be held secure to a neoprene gasket by stainless steel, quarter turn link locks. All hardware shall be stainless steel and no tools shall be required for routine maintenance. A retaining rod shall be provided to secure the door in the open position.

A three sided aluminum VISOR of not less than .063 inch thickness and 7 inches deep shall also be furnished and shall be securely fastened with corrosion resistant screws to the aluminum door, to shield the lens from the sun.

The finish colors shall be FEDERAL YELLOW 595A for the door, exterior and interior of the sign enclosure, and exterior surfaces of the visor. Apply the yellow by the dry powder method. Apply the yellow finish by electrostatic spray and heat cure. Ensure the thickness of the finish is a minimum of 2.5 mils thick. Do not apply paint to the latching hardware. Paint two coats of DULL BLACK for the inside of the visor, and for the part of the door within the visor.

All mounting hardware shall be furnished for Span-Wire mounting, as requested by the purchase order. Hardware for Span-Wire shall be finished Federal YELLOW

For Span-Wire mounting, the HANGER shall be cast ALUMINUM, and shall contain two (2) stainless steel J-Hooks with stainless steel lock washers and nuts, and have seven (7) notches to position the hanging signal. A double weatherhead entrance shall be used. The weatherhead entrance BUSHING shall have a 38 mm (1-1/2 inch) hole for wire entry. That entrance diameter shall be maintained throughout the weatherhead, without restriction or reducing the hole diameter, into the signal head. No special tools shall be required to tighten or adjust signal heads. Span wire hangers shall not require disassembly to install on span wire.

A fastener shall be installed in the bottom of the sign housing to provide for attachment to a tether cable of ¼ inch diameter.

Provide a symbolic display that is a PCB matrix with a mat black solder mask with minimum thickness of 0.093 inches and a silk screened component identifier. Mount LEDs on front of the PCB matrix. Mount all other components on the back of the black matrix. Ensure that a person with 20/20 vision can read a fully intensified, legible message from 500 feet in front of the sign under any light conditions. Ensure the message is not legible when the sign is off, even if in direct sunlight.

Use red LEDs that are the latest AlN GaP Technology and white LEDs that are the latest In GaN technology or better with a minimum luminous intensity of 6,000 mcd at 20 mA. Distribute the LEDs evenly. Ensure that the maximum distance, center to center, between consecutive LEDs is 0.5 inches, plus or minus 10%. Connect the individual LED light sources so that failure of a single LED will result in a loss of no more than 5 LEDs. Protect and seal the rear side of the PCB with a molded polymeric back cover. Mount the display PCB with back cover into the front door, which consist of an aluminum frame and face lens. Provide a clear 0.25-inch, non-glare, mat finish polycarbonate lens with a UV resistant surface treatment. Ensure that the lens has light transmission properties equal to or greater than 80%. The module shall be completely sealed against moisture and dust intrusion.

Provide an aluminum driver rack assembly that is a single part, self-contained module consisting of an interconnect PCB and an anodized aluminum frame. Ensure that it is vented from top to bottom and has latches to lock the modules in place. Design the driver rack assembly to be easily removable in less than one minute without the use of tools.

Design the driver modules to be industry standard 6.5 x 4.5 inches rack mounted. Provide driver modules that consist of a PCB with aluminum front plate and handle as used for inductive loop detectors. Ensure that the LED current does not exceed the manufacturer's maximum current rating. Ensure that the driver modules are fused. Provide voltage surge protection to withstand high repetition noise transients and low repetition high energy transients as stated in section 2.1.6 of the NEMA Standard TS-2, 1992.

Ensure compatibility and proper triggering and operation with load switches and conflict monitors in signal controllers currently used by the Department. Ensure the on-board circuitry meets FCC title 47, sub-part B, section 15 regulations on the emission of electronic noise. Design the driver modules to maintain a constant LED drive current regardless of the outside temperature.

Design the driver modules to automatically reduce the light intensity of the display by 35% based on the ambient light to reduce long term degradation of the LEDs. Include a 30-second delay to prevent interference caused by extraneous light. Provide a green LED for power status and a red LED for alarm status on the drive module.

Design the interconnect PCB to include terminals for all field wiring, 120VAC controls, external photocell, and alarm signals. Design all interconnections within the sign to be accomplished through the PCB with no internal wiring with the exception of a single cable for the message display and wires from the input terminal block. Provide a multi-conductor cable with an individual 2-pin connector for each word. Identify all connectors and terminals by the silk screen identifier on the surface of the PCB. Mount all PCBs vertically to facilitate air-cooling and to prevent collection of dust and moisture.

Design and certify the LED blank out sign to operate over a temperature range of -40°F to 165°F with an operating voltage range of 105 to 130 volts. Ensure that all electronic components are standard industry items that are available from wholesale electronics distributors. Provide components that are "solid state" type. Do not use electro-mechanical components such as relays, transformers or solenoids.

Identify each module with the manufacturer's name, model number, serial number, date of manufacture, and lot number if applicable.

2. **PACKAGING** -

Each single symbolic blankout sign, complete with visor, and LED Symbolic module capable of displaying either a right or left arrow, as specified, completely assembled with mounting assembly and tether fastener, shall be packaged in a separate corrugated cardboard box. It shall be clearly labeled on the END of the box, in plain English, as to what's contained therein.

3. CERTIFICATION AND QUALITY CONTROL -

Contractor shall provide written Certification from the **Manufacturer or Vendor** that ITE Standards and the requirements of this specification have been met.

NOTE: CATALOG CUTS REQUIRED

4. GUARANTEE -

During the period of **SIXTY (60) MONTHS** following the date of ACCEPTANCE, the Manufacturer or Vendor shall replace, at no expense to the Department (including shipping costs), any part of Symbolic LED Blankout Sign that fails by reason of defective material or workmanship.

Performance shall be warranted for a period of **SIXTY (60) MONTHS** of the date of installation and shall include repair or replacement of an LED NRT/NLT module that exhibits light output degradation, which in the judgement of the department, cannot be easily seen at one hundred fifty feet (150') in bright sunlight with the visor on the housing or that drops below the luminous intensity output requirements of this specification. The vendor shall replace any failed modules within 30 calendar days of notification.

5. CONSTRUCTION METHODS -

5.1 Location -

The Blankout Message Signal Heads shall be installed where shown on the Plans, positioned according to the Design Details or the Standards, or at other locations as directed by the Engineer.

5.2 Wiring -

5.2.1 Electrical cable shall be splice-free lengths of:

NO. 14 COPPER WIRE, 4 CONDUCTOR, BLACK

or as directed by the Engineer.

5.2.2 External splicing of cable shall NOT be permitted. Electrical cable runs shall be as indicated in these Specifications, and as shown on the Plans.

5.3 Hardware -

5.3.1 All hardware is to be non-corrosive material, or chemically compatible with the item being used.

5.3.2 All Blankout Signal Heads which are to be rigid mounted shall be done so by the use of adjustable signal brackets.

5.3.3 All brackets and suspensions shall be painted Federal YELLOW or as directed by the Engineer (Except mast arm mounts).

5.4 Mounting -

All Blankout Signal Heads shall be mounted as shown on the Design Details or on the Standards.

6. SIGNAL AIMING -

6.1 Signal faces are to be hung and aimed to insure good visibility, to the satisfaction of the Engineer. Blank out signs should generally be aimed to have the brightest image result, at about 10 metres (30 feet) beyond the stop line.

7. METHOD OF MEASUREMENT -

The furnishing and installing of blankout sign shall be measured by EACH with LED module installed, including ALL internal electrical connections and all incidental hardware. Electrical cable shall be measured separately if an item has been established in the Bid or Proposal.

8. BASIS OF PAYMENT -

Installing and/or furnishing blankout sign with LED module, measured as provided above, will be paid at the contract unit price bid for:

FURNISH AND INSTALL LED BLANKOUT SIGN-EACH

INSTALL LED BLANKOUT SIGN-EACH

and such payment shall be full compensation for furnishing and placing the specified equipment, Signal Head aiming, electrical connections, and all necessary hardware and incidentals.

FURNISH AND INSTALL POLYCARBONATE VEHICLE SIGNAL HEADS WITH LED MODULES

Description

This item consists of installing and/or furnishing POLYCARBONATE VEHICLE SIGNAL HEADS with LED Modules of the types, sizes, and mounting specified, in accordance with these Specifications. The signal modules shall maintain the pixilated appearance typical with earlier generations of LED's modules. The Department wants the option of having the entire signal module go dark after 40% of the LED's fail. Some heads require ALUMINUM sections. All SIGNAL HEADS shall be supplied with a 'RED', 'YELLOW' & 'GREEN' LED Module installed and operational.

Materials

Signal Heads

All Signal Heads shall conform to the July 1998 Interim Purchase Specifications of the ITE VTCSH part 2 (Light Emitting Diode (LED) Vehicular Traffic Signal Modules (hereafter referred to as VTCSH-2) published by the INSTITUTE OF TRANSPORTATION ENGINEERS (ITE), "Standard for Adjustable Face Vehicular Traffic Control Signal Heads" (latest Revision). All heads shall be furnished by the SAME MANUFACTURER as well as each module in the head. Polycarbonate Vehicle Signal Heads of the size, type, and arrangement specified, are to be furnished by the Manufacturer or Vendor, together with ALL the necessary hardware for make-up and mounting. The basic material requirements are listed below:

a) *Housing*

The COLOR shall be Federal YELLOW.

Each Signal Head housing shall consist of an assembly of separate interchangeable sections, each holding an individual optical unit, and stainless steel parts between the signal heads, including the tri-std coupling washer and bolts. THE TOP SECTION OF EACH 3-SECTION HEAD SHALL HAVE AN ALUMINUM REINFORCING / BEARING PLATE INSIDE THE HEAD. The Aluminum reinforcing / bearing plate retaining screws shall provide for a watertight seal to prevent water from entering the housing. The TOP SECTION OF THE FIVE-SECTION CLUSTER, AND OF THE FOUR-SECTION IN-LINE, SHALL BE ALUMINUM. The rest of those configurations shall be POLYCARBONATE.

The material of the Housing, Door, and Visor shall be engineering-grade structural, ultraviolet-stabilized PURE POLYCARBONATE resin. Other plastics are NOT acceptable. All edges shall be milled to a uniform round edge and free of all sharp edges.

b) *Polycarbonate*

The Department is aware of the design characteristics of this material--particularly the fact that as fillers are added for strength, the material becomes more brittle. We also recognize that signal manufacturers have optimized their designs around a specific formulation. There is also a requirement for an un-filled polycarbonate lens material that is strong, but will not darken (burn) or color fade. Therefore the VENDOR shall provide complete particulars about the polycarbonate type number proposed, for both the HOUSING and for the LENSES. Further the VENDOR shall submit strength and wind tunnel test results (See Paragraph 1.2.5 Certification)

c) *Door*

The COLOR shall be Federal YELLOW.

The door latches shall consist of stainless steel latch eye-bolts, wing-nut, and washer; all retained to keep them from falling to the street. No special tools shall be necessary to unlatch and open a door. Doors shall be easily removed; hinge-pin shall not have to be driven out to remove door.

The hinges shall be reinforced protrusions (mortise and tenon) from the door, with a minimum of one stainless-steel pin.

d) Visor

The Visor COLOR shall be Federal YELLOW outside, and dull BLACK inside.

The Visor CLASSIFICATION shall be TUNNEL (slot at bottom), unless otherwise specified.

The Visor shall be twist-on, attached to the housing with four stainless steel SCREWS, through the twist-on tabs on the visor.

e) Wiring

Wiring and Electrical shall be in accordance with ITE Standards. Color Coded wiring shall be factory connected to a barrier type TERMINAL BLOCK in the LOWER PORTION OF THE RED SECTION of each Signal Head. In the five-section cluster, the TERMINAL BLOCK shall be located in the (TOP) SECTION.

The TERMINAL BLOCK shall be double sided barrier type with two screws per barrier section; and shall make connections to the lamp wires using fast-on SPRING-LOADED SPADE LUGS and screws, (i.e. provisions should be made so that spade lugs or screws can be used on the same terminal block.) ONE PER SCREW. More than one neutral is allowed per terminal. The number of barrier sections in the TERMINAL BLOCK for the three and four section head, shall be 6-position, 12-terminal. For the five section head, it shall be 8-position, 16-terminal.

f) Mounting Assemblies

All mounting hardware shall be furnished for Span-Wire mounting, as requested by the purchase order. Hardware for Span-Wire shall be finished Federal YELLOW

For Span-Wire mounting, the HANGER shall be cast ALUMINUM, and shall contain two stainless steel J-Hooks with stainless steel lock washers and nuts, and have seven notches to position the hanging signal. A double weatherhead entrance shall be used. The weatherhead entrance BUSHING shall have a 1-1/2 inch hole for wire entry. That entrance diameter shall be maintained throughout the weatherhead, without restriction or reducing the hole diameter, into the signal head. No special tools shall be required to tighten or adjust signal heads. Span wire hangers shall not require disassembly to install on span wire.

For Span-Wire mounting, for MULTI-WAY heads, there shall be included a "SWIVEL BALANCE ADJUSTER" for proper vertical alignment.

For 5-SECTION CLUSTER signal assemblies, ONE Span-Wire Hanger shall be furnished, attached to the top signal section. The configuration shall be FHWA MUTCD TYPE 'S', known as the "dog-house head". At the bottom of the top signal section, a cast-aluminum bracket shall connect with the arrow side, and with the ball indication side. This bracket shall have a removable, threaded "knockout" plug at each 90-degree turn, to facilitate wiring.

A 2 inch wide ribbed, cast aluminum BOTTOM BRACKET (No. 10 018 or equiv.), having holes 17 inches on-center, shall be used to unify the assembly. (The two sides of the cluster shall be not more than 8 inches apart.)

For 4-SECTION "T" ASSEMBLY, ONE Span-Wire Hanger shall be furnished, together with two cast aluminum brackets. The two red sections shall be not more than 8 inches apart.

g) Balance Adjuster

When needed, a Balance adjuster shall be aluminum with a 3/4" WEH. It shall be furnished Federal Yellow and shall have stainless steel bushing, stainless steel hardware, and a stainless steel eye. This item, as part of a furnish contract, shall not come attached to the signal head assemblies.

2. LED Modules

Provide modules that consist of an assembly that utilizes LEDs as the light source in lieu of an incandescent lamp for use in traffic signal sections. Use LEDs that are AlInGaP technology for red and yellow indications and InGaN for green indications. Install the ultra bright type LEDs that are rated for 100,000 hours of continuous operation from -40°C to +74°C. Design modules to have a minimum useful life of 60 months, and to meet all parameters of this specification during this period of useful life.

Ensure, unless otherwise stated in these specifications, that each module meets or exceeds the requirements of the Interim Purchase Specification of the ITE VTCSH part 2 (Light Emitting Diode (LED) Vehicular Traffic Signal Modules (hereafter referred to as VTCSH-2). Arrow displays shall meet or exceed the electrical and environmental operating requirements of VTCSH-2 sections 3 and 5, chromaticity requirements of section 4.2, and the requirements of sections 6.3 (except 6.3.2) and 6.4 (except 6.4.2).

Each LED module supplied shall be factory installed in vehicle signal head or shipped as a complete kit designed for retrofitting existing traffic signal sections with an LED display module.

Lamp socket 'Screw-in' type products shall not be allowed for vehicle traffic signals.

a) Electrical

Provide modules that have maximum power consumption equal to or below the requirements of Table 1. Design the modules to operate from a 60 ± 3 HZ AC line voltage ranging from 80 volts to 135 volts. Ensure that fluctuations of line voltage have no visible effect on the luminous intensity of the indications. Design the module to have a normal operating voltage of 120 VAC, and measure all parameters at this voltage.

Certify that the module has a power factor of 0.90 or greater, and that THD (current and voltage) induced into an AC power line by the module does not exceed 20 percent for modules with power ratings above 15W, and 40 percent for modules with power ratings of 15W or less. Design the modules onboard circuitry to include voltage surge protection to withstand high repetition noise transients as stated in Section 2.1.6 of NEMA Standard TS-2, 1992. Ensure all wiring meets the requirements of Section 13.02 of the ITE Publication: Equipment and Material Standards, Chapter 2 (VTCSH). Provide spade terminals appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head.

Ensure that the module is compatible with signal load switches and conflict monitors. Design the module to provide sufficient current draw to ensure proper load switch operation while the voltage is varied from a regulated 80Vrms to 135 Vrms. Design off-state for green and yellow modules to be 30Vrms or greater, and on-state to be 40Vrms or greater. Also for green and yellow modules, design the voltage decay to 10 Vrms or less to be 100 milliseconds or less. Ensure that the control circuitry prevents current flow through the LEDs in the off state to avoid a false indication.

Design all modules to meet existing SCDOT monitor specifications for the following type of signal monitors: 170 controller/cabinet Type 210, 2010 and 2010ECL conflict monitors (including red

monitoring and so-called plus features such as dual indication detection and short yellow time detection).

Ensure that the modules and associated onboard circuitry meet Class A emission limits referred to in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

b) Photometric and Chromaticity Requirements

The maintained minimum luminous intensity values for the modules are shown in Tables 2, and 4. Test all ball modules for luminous intensity at 25°C to meet 115% of values in table 2. Design and certify the modules to meet or exceed the maintained minimum luminous intensity values throughout the warranty period based on normal use in a traffic signal operation over the operating temperature range. Test the Red and Green modules for maintained luminous intensity (tables 2 & 3) at 74°C (ITE 6.4.2.2). Use LEDs that conform to the chromaticity requirements of VTCSH Chapter 2, Section 8.04 throughout the warranty period over the operating temperature range. Make chromaticity coordinate compliance measurements at 25°C.

c) Physical and Mechanical Requirements

Design the modules as retrofit replacements for installation into standard incandescent traffic sections that do not contain the incandescent lens, reflector assembly, lamp socket and lens gasket. Ensure that installation does not require special tools or physical modification for the existing fixture other than the removal of the incandescent lens, reflector assembly, lamp socket, and lens gasket.

d) Environmental Requirements

Provide modules that are rated for use in the operating temperature range of -40°C (-40°F) to +74°C (+165°F). Ensure that the modules (except yellow) meet all specifications throughout this range. Fabricate the module to protect the onboard circuitry against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal components.

e) Module Construction

Design the module to be a single, self-contained device with the circuit board and power supply for the module inside and integral to the unit.

Design the assembly and manufacturing process for the module to ensure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources. Wire the individual LEDs such that a catastrophic loss or the failure of one LED will result in the loss of not more than 20 percent of the signal module light output. LEDs shall be soldered to the circuit board.

f) Materials

Fabricate the lens and signal module from material that conforms to ASTM specifications. Enclosures containing either the power supply or electronic components of the module shall be made of UL94VO flame retardant materials. The lens of the signal module is excluded from this requirement.

g) Module Identification

Permanently mark the manufacturer's name, trademark, model number, serial number, date of manufacture (month & year), and lot number as identification on the back of the module.

Permanently mark the following operating characteristics on the back of the module: rated voltage and rated power in Watts and Volt-Ampere.

If a specific mounting orientation is required, provide permanent markings consisting of an up arrow, or the word "UP" or "TOP" for correct indexing and orientation within the signal housing.

h) Lens

Provide a lens that is integral to the unit with a smooth outer surface and UV stabilized to withstand ultraviolet exposure for a minimum period of 60 months without exhibiting evidence of deterioration. Coat the front of a polycarbonate lens to make it more abrasion resistant. Seal the lens to the module to prevent moisture and dust from entering the module.

Tint the red and yellow lens to match the wavelength (chromaticity) of the LED. Provide a green lens that is either colorless or tinted to match the wavelength (chromaticity) of the LED.

i) 12 Inch Arrow

The following specification requirements apply to the 12 inch (300 mm) arrow module only, which is the only size arrow allowed. All general specifications apply unless specifically superceded in this paragraph. Ensure that the arrow module meets specifications stated in Section 9.01 of the ITE VTCSH for arrow indications. Design arrow displays to be solid LEDs (spread evenly across the illuminated portion of the arrow or other designs) not outlines. Determine the luminous intensity using the CALTRANS 606 method or similar procedure (<http://itvendors.dot.ca.gov/hq/esc/ctms/ctmsindex600.html>).

j) Testing

Provide test results for ball modules from an independent testing laboratory showing wattage and compliance with ITE VTCSH Part 2 specifications 6.4.2, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.5, and 6.4.6.1 as a minimum. The 6.4.2.1 test shall meet the requirements of Table 2 of this specification. The 6.4.2.2 test is for Red and Green only. Ensure that the LED signal modules tested are typical, average production units.

Burn In

Energize the sample module(s) (a sample of one module minimum) for a minimum of 24 hours, at 100 percent on-time duty cycle, at a temperature of +74°C (+165°F) before performing any qualification testing. Any failure of the module, which renders the unit non-compliant with the specification after burn-in, shall be cause for rejection. All specifications will be measured including, but not limited to:

Photometric (Rated Initial Luminous Intensity)

Measure at +25°C. Measure luminous intensity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. Measure luminous intensity for yellow modules immediately upon energizing at the rated voltage.

Chromaticity (Color)

Measure at +25°C. Measure chromaticity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. Measure chromaticity for yellow modules immediately upon energizing at the rated voltage.

Electrical

Measure all specified parameters for quality comparison of production quality assurance on production modules. (rated power, etc)

Equipment Compatibility

In addition to the 6.4.4.5 test of modules for compatibility with controllers, conflict monitors, and load switches, perform the following test, and certify the results. Connect each signal module to the output of a standard load switch connected to a variable AC voltage supply (95 to 135 VAC). With the load switch "off," vary the AC voltage from 95 Vrms to 135 Vrms, and measure the drop across the module. Readings greater than 15 Vrms are unacceptable.

k) Photometric Maintenance

Provide testing at an independent laboratory for a designated module to be tested for maintained luminous intensity at 25°C once each year during the five-year warranty period.

3. Tables

Table 1 Maximum Power Consumption (in Watts)

	Red	Yellow	Green
Temperature	25°C	25°C	25°C
12"(300 mm) circular	17	25	24
12"(300 mm) arrow	9	10	11

Table 2 Minimum Initial and maintained Intensities for Arrow Indications (in cd/m2)

	Red	Yellow	Green
Arrow Indication	5,500	11,000	11,000

Note: Use CALTRANS 606 method or similar procedure.

Table 3 Chromaticity Standards (CIE Chart)

Red	Y: not greater than 0.308, or less than 0.998 - x
Yellow	Y: not less than 0.411, nor less than 0.995 - x, nor less than 0.452
Green	Y: Not less than 0.506 -.519x, nor less than 0.150 + 1.068x, nor more than 0.730 - x

Table 4 Specification for 12 inch Extended View Signals in South Carolina

Minimum Luminous Intensity Values (In Candelas)				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	339	678	678
	7.5	251	501	501
	12.5	141	283	283
	17.5	77	154	154
+/-7.5	2.5	226	452	452
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178

Minimum Luminous Intensity Values (In Candelas)				
	22.5 27.5	38 16	77 32	77 32
+/-12.5	2.5 7.5 12.5 17.5 22.5 27.5	50 48 44 34 22 16	101 97 89 69 44 32	101 97 89 69 44 32
+/-17.5	2.5 7.5 12.5 17.5 (Not Extended View) 22.5 (Not Extended View) 27.5	22 22 22 22 20 16	44 44 44 44 41 32	44 44 44 44 41 32
+/-22.5	2.5 17.5	20 20	40 40	40 40

Notes:

Design signal modules to meet these requirements as a minimum throughout the warranty period.

Design signal modules to have a minimum initial intensity equal to 115% of Table 2 at 25°C. Independent laboratory test reports are required to validate the initial intensity.

4. Signal Backplate

A Signal Backplate constructed of thin strip of polycarbonate material that extends outward from and parallel to a signal face on all sides of a signal housing to provide a background for improved visibility of the signal locations shall be installed on all Signal Heads. Signal backplates shall be appropriate for the size and manufacturer of each signal head. A strip of 2 inch yellow reflective tape shall be affixed to the outer edge of the signal backplate. Diamond grade tape is preferred. All signal backplates with reflective borders shall conform to the SCDOT Standard Drawings.

5. Certification

The CONTRACTOR SHALL PROVIDE written Certification from the Manufacturer that 1998 ITE STANDARDS have been met.

The CONTRACTOR SHALL PROVIDE design details and drawings in sufficient detail for complete evaluation and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing at that time.

NOTE: CATALOG CUTS REQUIRED

The CONTRACTOR SHALL PROVIDE written specifications (product sheets) for the specific POLYCARBONATE (LEXAN TYPE NO.) formulation that is proposed. Bids shall provide the tests results for the IZOD IMPACT tests.

Housing Type No. _____ or See Attached Letter _____

The CONTRACTOR SHALL PROVIDE written TEST RESULTS DEMONSTRATING THE STRENGTH OF THE 3-SECTION SIGNAL HEAD. The test signal shall not have the SCDOT aluminum bearing plate installed. The tests should include static stress and wind tunnel setups

Sample modules shall be provided for Department approval upon request. The sample modules submitted shall be representative of typical average production units. Samples will not be returned unless requested by the vendor.

The manufacturer of LED Modules shall have previously supplied indications to other states or cities and shall supply a list of these cities and/or states with the bid. The reference shall include name of city or state, contact person and model number of the LED display(s) previously supplied.

Sample modules shall be provided for Department approval upon request. The sample modules submitted shall be representative of typical average production units. Samples will not be returned unless requested by the vendor.

6. Warranty

The CONTRACTOR shall furnish the RCE with any warranties on equipment, materials, modules and lamps that are provided by the Manufacturer or Vendor as normal trade practice.

During the period of TWELVE (12) MONTHS following the date of ACCEPTANCE, the Manufacturer or Vendor shall replace, at no expense to the Department (including shipping costs), any part of Polycarbonate Vehicle Signal Head that fails by reason of defective material or workmanship, including peeling or chipping paint.

In addition to meeting the performance requirements for the minimum period of SIXTY (60) MONTHS, provide a written warranty against defects in materials and workmanship for the modules for a period of 60 months after shipment acceptance of the modules. Replacement modules shall be provided within 30 days of receipt of modules that have failed at no cost to the State. All warranty documentation shall be given to the Department prior to BID acceptance.

Construction

Location

Polycarbonate vehicle signal heads shall be installed where shown on the plans, positioned according to the design details or the standards or at other locations as directed by the DES.

The top section of all vehicle signal heads mounted on the same pole or pedestal shall be within 6 inches of being the same height unless otherwise specified.

All multi-section/ combination signal heads shall be arranged with their top sections at the same elevation as other signal heads.

1. Clearance

Signal heads placed over the roadway shall be installed to provide a road clearance of 17 to 19 feet. This distance shall be measured from the pavement to the lowest part of the assembly.

2. Wiring

Electrical cable shall be connected to the terminals in each signal head to provide the proper display indication.

External splicing of cable is not permitted.

Electrical cable runs shall be as indicated in the specifications and on the plans.

3. Mounting

All traffic signal heads shall be mounted as shown on the design details or on the standard.

4. Aiming

Signal faces to be aimed to insure good visibility, and to the satisfaction of the RCE. The following guidelines are to be followed:

- Rural Areas - aimed at 1000 feet
- Suburban Areas - aimed at 500 feet
- Urban Areas - aimed at 300 feet

In no instance is the signal face to be visible for a distance less than provided in the SC MUTCD table of Visibility Distance.

5. Signal Backplate

Signal Backplates shall be fastened using appropriate hardware recommended by the signal head manufacturer. The Backplate nor signal head shall not be altered to accommodate the Backplate installation.

Measurement

The furnishing and/or installing of polycarbonate vehicle Signal Heads shall be measured by EACH type of head assembly with mounting hardware as specified on plans, including ALL internal electrical connections and ALL required incidental hardware.

The furnishing and/or installing of LED modules shall be measured by EACH.

The furnishing and/or installing of Signal Backplate shall be measured by EACH including ALL required mounting hardware.

Payment

Installing and/or furnishing polycarbonate vehicle Signal Heads with 12 inch sections unless noted, measured as provided above, will be paid for at the contract unit price for:

**INSTALL ___-WAY ___-SECTION (*LENS-DESCRIPTION) – EACH
FURNISH AND INSTALL ___-WAY ___-SECTION (*LENS-DESCRIPTION) – EACH**

**INSTALL SIGNAL BACKPLATE – EACH
FURNISH AND INSTALL SIGNAL BACKPLATE – EACH**

**INSTALL LED MODULES (1-100 MODULES) – EACH
INSTALL LED MODULES (101-500 MODULES) – EACH
INSTALL LED MODULES (501-1000 MODULES) – EACH**

Typical *LED-Descriptions

1-W 3-S	R-LED.Y-LED.G-LED
1-W 3-S	RA-LED.YA-LED.GA-LED (Left)
1-W 4-S	RA-LED+RA-LED.YA-LED.GA-LED (Left)
1-W 4-S	R-LED.Y-LED.G-LED.GA-LED (Left)
1-W 5-S	R-LED.YA-LED.GA-LED.Y-LED.G-LED (Left)
1-W 5-S	R-LED.YA-LED.GA-LED.Y-LED.G-LED (Right)
4-W 1-S	R-LED.Y-LED.R-LED.Y-LED
1-W 3-S	R-LED(12").Y-LED(12").Y-LED(8")
1-W 1-S	R-LED
1-W 1-S	Y-LED
1-W 1-S	G-LED
1-W 1-S	RA-LED
1-W 1-S	YA-LED
1-W 1-S	GA-LED

and such payment shall be full compensation for installing and/or furnishing the specified equipment, materials, and incidentals to complete this item.

FURNISH AND INSTALL OPTICALLY PROGRAMMABLE VEHICLE SIGNAL HEADS

DESCRIPTION - This work shall consist of installing and/or furnishing HIGH VISIBILITY, OPTICALLY PROGRAMMABLE, ADJUSTABLE FACE 300 MM (12 INCH) VEHICLE SIGNAL HEADS of the types, display, and at locations shown on the Plans, in accordance with these Specifications, and in close conformity with the lines shown on the Plans or established by the Engineer. Vehicle signal heads are stated separately from their mounting hardware. These signals are intended for use where the field of view must be limited, or where the features of high conspicuity is desirable. Hereinafter, Optically Programmable Signals shall be stated as OPS.

1. MATERIALS -

All OPS heads shall be furnished by the SAME MANUFACTURER. Vehicle OPS Heads of the size, type, and arrangement specified, are to be furnished by the Contractor, together with ALL the necessary hardware for make-up and mounting. The basic material requirements are listed below.

1.1 General -

The OPS shall permit the visibility zone of the signal indication to be determined optically; and shall require no hoods nor louvers to achieve that effect. The projected indication may be selectively visible (or veiled) anywhere within 15° of the optical axis. No indication shall result from external illumination (phantom), nor shall one light unit illuminate a second.

1.2 Optical System -

The components of the optical system shall consist of:

1. Lamp
2. Diffuser Collar
3. Optical Limiter-Diffuser
4. Objective Lens

1.2.1 The LAMP shall be nominal 150 watt, 115 VAC, three prong, sealed beam PAR, having an integral reflector with stippled face, and having an average rated life of 6,000 hours when operated (with dimming) in an OPS according to manufacturer's specifications. Signal heads shall be furnished fully lamped. The Contractor must acquire sufficient spare lamps for operation until Final Acceptance.

1.2.2 The OPTICAL LIMITER shall provide an accessible imaging surface, which is at focus on the optical axis, for objects at a 275 to 365 metres (900 to 1200 feet) distance, and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be provided with positive indexing means, and be composed of heat resistant glass.

1.2.3 The OBJECTIVE LENS shall be a high-resolution annular, incremental lens, which is hermetically sealed within a flat laminate of weather-resistant acrylic (or approved equal). The lens shall be symmetrical in outline, and may be rotated to any 90° orientation about the optical axis without displacing the primary image.

1.2.4 The OPTICAL SYSTEM shall accommodate projection of diverse, selected indications to separate portions of the roadway, such that only one indication will be simultaneously apparent to any viewer. The projected indication shall conform to ITE transmittance and chromaticity standards.

1.3 Housing Construction -

1.3.1 The primary outer housing shall be die-cast ALUMINUM parts (NOT plastic), and shall conform to ITE alloy and tensile requirements. Painted parts shall have a chromate preparation prior to painting. The exterior of the signal case, lamp housing, and mounting flanges shall be finished with POWERED PAINT of FEDERAL YELLOW. The lens holder and interior of the case shall be optically flat black.

1.3.2 The signal case and lens holder shall be pre-drilled for backplates and visors. The hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather-resistant rubber gaskets. Each section shall have two drain holes.

1.3.3 Sheet metal parts, including visors and backplates, shall conform to ITE material requirements, and shall include a chromate preparatory treatment, and be finished optically flat black on all surfaces unless otherwise specified.

1.4 Mounting -

1.4.1 The signal shall mount to industry standard 38.1 mm (1.5 inch) N. P. T. fittings as a single-section, as a multiple-section face, or in combination with other signals. The signal section shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal, while maintaining a common vertical axis, through couplers and mounting. Terminal connection shall permit external horizontal adjustment about the mounting axis, in 5 degree increments. The signal shall be installable with ordinary tools, and serviceable without tools.

1.4.2 Attachments such as visors, backplates or adapters shall conform, and readily fasten to existing mounting surfaces without affecting the sealing nor light integrity of the signal.

1.4.3 Contractor: note set-off requirements, that are particularly applicable to mast-arm mounting brackets.

1.5 Electrical -

The Lamp Fixture shall consist of: a separately accessible housing with integral lamp support, an indexed ceramic socket, and a self aligning, quick-release lamp retainer. Electrical connection between case and lamp housing shall be accomplished with an interlock (plug) assembly which disconnects the lamp housing when opened. Each signal section shall include a covered terminal block for clip or screw attachment of field wires. The OPS shall be pre-wired, with concealed #18 AWG, stranded and coded wires, which shall interconnect all sections to permit field connection within any section.

1.6 Photo Controls -

1.6.1 Each signal shall include integral means (dimmer/intensity controller) for regulating the intensity of light output, (between limits) as a function of individual background ambient illumination. Lamp intensity shall not be less than 97% of the uncontrolled intensity at 10700 Lumens/sq.-metre (1000 ft.-candle); and shall reduce to 15% (\pm 2%) of maximum intensity at light levels less than 10.7 Lumens/sq.-metre (1 ft.-candle), (over the applied voltage and ambient temperature range). Response shall be proportional, and be essentially instantaneous to any detectable increase from darkness up to 10700 Lumens/sq.-metre (1000 ft.-candle); and be damped for any decrease below 10700 Lumens/sq.-metre (1000 ft.-candle).

1.6.2 The intensity controller shall be comprised of an integrated, directional light sensing and regulating device, inserted between lamp and field wires.

1.6.3 The device shall be responsive over an applied voltage of 95 to 130 VAC, 60 Hz.; and a temperature range of -40 to 74°C (-40 to +165°F); and may provide phase controlled output voltage, but shall have a nominal open circuit terminal impedance of 1000 ohms.

1.7 Mounting Assemblies -

1.7.1 All mounting hardware shall be furnished for either Span-Wire, Mast-Arm, Side-Pole, or Post-Top mounting as required by the Plans. Hardware for Span-Wire, Side-Pole, and Post-Top mounting shall be finished Federal YELLOW. The adjustable brackets for Mast-Arm mounting shall have a finish of NATURAL stainless steel or aluminum.

1.7.2 For Span-Wire mounting, the hanger shall be CAST ALUMINUM, and shall contain two stainless steel (2) J-Hooks, and have six (6) notches to position the hanging signal. The weatherhead entrance BUSHING shall have a 38 mm (1.5 inch) hole for wire entry. All span-wire mounted OPS shall have a fitting for attaching the Bottom-Tether cable, which shall be installed by the Contractor. For span-wire mounted OPS, the manufacturer shall provide, and the Contractor install, a 1067 mm (42 inch) BOTTOM STABILIZER BAR, which shall have a finish of NATURAL stainless steel or aluminum.

1.7.3 For 5-SECTION CLUSTER signal assemblies, ONE mounting bracket top-fitting shall be furnished, attached to the single top red section. Then a pipe T-section will connect to both two-section sides, forming a 5-section "school-house" shaped cluster. (See Design Detail drawing.) A 50 mm (2 inch) wide ribbed, cast aluminum BOTTOM BRACKET (No. 10 018 or equiv.), having holes 430 mm (17 inches) on-center, shall be used to unify the assembly. (The two sides of the cluster shall be not more than 200 mm (8 inches) apart; and the bottoms shall be level.)

1.7.4 For 4-SECTION "T" ASSEMBLY, ONE mounting bracket top-fitting shall be furnished, together with two (2) cast aluminum brackets. (See Design Detail Drawings.) The two red sections shall be not more than 200 mm (8 inches) apart.

1.8 Backplate -

1.8.1 Where specified, a BACKPLATE conforming to the size and shape of the required signal configuration, shall be provided by the same Manufacturer. Back plates shall be ALUMINUM, and shall be colored dull black front and back. The color shall be anodized.

1.8.2 All Span-Wire mounted signals having a Backplate, shall have a bottom TETHER.

2. PACKAGING -

2.1 Each single span-wire mounted traffic signal, complete with hangers and visors, completely assembled, shall be packaged in a separate corrugated cardboard box. It shall be clearly labeled on the END of the box, in plain English, as to the type of signal contained therein. For other types of Signal Heads, again, the signal shall be complete in its own box, with a separate plainly labeled box containing the brackets, trunions, and miscellaneous hardware. (For example labeled: "Side-arm hardware for 300 mm (12 inch) pedestrian signal".)

2.2 Four- and Five-section cluster signals shall likewise be singly boxed, completely assembled, with visors and span-wire mounting hardware. Because of the weight, five-section clusters shall be packed 2 or 3 per standard pallet.

2.3 Backplates may be packaged separately and shall be protected from shipping damage to the paint.

3. CERTIFICATION -

3.1 The Contractor shall provide a written Certification from the Manufacturer that ITE STANDARDS have been met (for heads & lamps.)

3.2 The Contractor shall provide design details and drawings in sufficient detail for complete evaluation of the Proposal, and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing.

NOTE: CATALOG CUTS ARE REQUIRED

3.3 Samples -

Upon request of the Engineer, the Contractor shall submit for approval, one (1) sample of EACH required Signal Head type specified. For example, one Three-Hundred-MM (12-inch) 3-section vehicle head; etc., if specified. The hardware system for producing a 5-section cluster shall be completely illustrated, but sample is not required.

4. **GUARANTEE** -

4.1 The Contractor shall furnish the Engineer with any warranties on equipment, materials and lamps, that are provided by the Manufacturer or Vendor as normal trade practice.

5. **CONSTRUCTION METHODS** -

5.1 Location and Aiming -

5.1.1 OPS Heads shall be installed where shown on the Plans, and shall be positioned according to the Design Details or the Standards, or at other locations as directed by the Engineer.

5.1.2 Following "turn-on" of the new controller and new OPS, the Engineer shall field inspect the visibility zone, and shall instruct the Contractor to revise the masking if necessary.

5.2 Installation -

5.2.1 Mounting. The OPS shall be mounted and aimed before masking. For span wire mounting, the top cable shall have 3% sag, and a taught bottom tether shall be installed, together with the stabilizer bar. There shall be no sway or movement in a 25 KPH (15 MPH) wind.

5.2.2 Aiming. The OPS shall be installed, aimed and masked as recommended in the Manufacturer's "Installation Instructions and Design, Installation and Maintenance Guide". It is the responsibility of the Contractor to be thoroughly familiar with this manual, and with the techniques of masking. Each section of the signal shall be masked with special heat-proof OPS Masking Tape in an acceptable and professional manner.

5.3 Mounting Details -

5.3.1 The top section of all vehicle Signal Heads mounted on the same pole or pedestal shall be within 150 mm (6 inches) of all being the same height, unless otherwise specified on the Plans.

5.3.2 All multi-section/combination Signal Heads shall be arranged with their TOP sections at the same elevation as other Signal Heads (rather than the bottom of the head).

5.4 Clearance -

5.4.1 Signal heads placed over the roadway shall be installed to provide a ROAD CLEARANCE of 5 to 5.8 metres (17 to 19 feet). This clearance shall be measured from the pavement to the lowest part of the assembly.

5.4.2 Signal heads mounted on poles or pedestals shall be mounted to provide a nominal clearance of 3 metres (10 feet); ranging from 2.4 to 4.6 metres (8 to 15 feet) above the surface grade.

5.5 Wiring -

5.5.1 Electrical cable shall be connected to the terminals in each Signal Head to provide the proper display indication when the other end is connected to the controller cabinet field terminals.

5.5.2 External splicing of cable shall NOT be permitted. Electrical cable runs shall be as indicated in these Specifications, and as shown on the Plans.

5.6 Hardware -

5.6.1 All hardware is to be non-corrosive material, or chemically compatible with the item being used. All Signal Heads which are to be rigidly mounted, shall be done so by the use of adjustable signal brackets. All brackets and suspensions shall be painted Federal YELLOW or as directed by the Engineer (except mast arm mounts which shall be natural.)

6. METHOD OF MEASUREMENT -

6.1 The furnishing and installing of Optically Programmable Signal Heads shall be measured by EACH type of head assembly specified, and mounting method specified. Included, shall be, Mounting Assemblies, bottom tether bracket, stabilizer bar and ALL electrical connections and all required incidental hardware.

7. BASIS OF PAYMENT -

7.1 Installing and/or furnishing OPS vehicle Signal Heads, measured as provided above, will be paid for at the contract unit price for:

12 INCH (300 MM) OPTICALLY PROGRAMMABLE 1 WAY-__SECTION
VEHICLE TRAFFIC SIGNAL LENS DESCRIPTION) -- EACH

Lens: R,Y,YA,G,GA; R+R,YA,GA; R,Y,GA,GA; R,Y,G; R,Y,GA

and such payment shall be full compensation for furnishing and placing the specified equipment, Signal Head aiming, MASKING, electrical connections, and for all necessary hardware and incidentals.

FURNISH AND INSTALL PEDESTRIAN SIGNAL HEADS

Description

This work shall consist of furnishing and installing either:

- 1) **LED (Light Emitting Diode) PEDESTRIAN SIGNAL HEADS**, with SUN VISOR and designated mounting hardware;

Or,

- 2) **LED (Light Emitting Diode) COUNTDOWN PEDESTRIAN SIGNAL HEADS**, with SUN VISOR and designated mounting hardware,

in accordance with these Specifications, and in reasonably close conformity with the lines shown on the Plans or established by the RCE. The pedestrian head and the mounting hardware are stated as one item.

Materials

Pedestrian Head Housing

All signal heads shall conform to the specifications of the INSTITUTE OF TRANSPORTATION ENGINEERS (ITE), "Pedestrian Traffic Control Signal Indications" (March 2004). All pedestrian signal heads shall be furnished by the same manufacturer and shall be new and current production models. Pedestrian signal heads of the size, type, and arrangement specified, are to be furnished, together with ALL the necessary hardware for make-up and mounting. For the purpose of this Specification, the basic material requirements are listed below:

a) General

All pedestrian signal heads shall use a SOLID display LED HAND/MAN module as a light source; a nominal message bearing surface of 16 inches; and SYMBOLIC MESSAGES; the Portland Orange a side-by-side display with UPRIGHT HAND for "Don't Walk", and Lunar White WALKING MAN for "Walk" OR a countdown display with a nominal message bearing surface of 16 inches with a SOLID SYMBOLIC MESSAGE Hand/Man overlay on the left and the countdown on the right.

b) Housing, Visor

The housing shall be a one piece ultra-stabilized, permanently colored, flame-retardant, PURE Polycarbonate resin. The materials and construction used shall comply with ITE Standards. A single housing shall contain the LED module. A weather tight neoprene gasket shall be provided. All hardware shall be stainless steel or aluminum. The DOOR shall swing down with two hidden hinges at the bottom, with removable locking pins. The DOOR shall be a corrosion resistant one-piece aluminum alloy die-casting, and pins.

A visor shall also be furnished and shall be securely fastened with corrosion resistant screws to the front of the signal housing, to shield the lens from the sun.

c) Finish

The finish colors shall be FEDERAL YELLOW (13538) for the door, housing, and exterior surfaces of the visor; and FLAT BLACK (37038) for the inside of the visor and for the part of the door within the visor.

d) Mounting

Brackets and related hardware shall be furnished for properly installing the pedestrian signal heads.

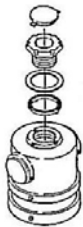
For *single post-top mount*.

A 1½” aluminum post top signal mounting shall be furnished. It shall consist of a slip fitter assembly for a one-way signal. It should be Pelco Product Part Number SE-3037 or equivalent with a FEDERAL YELLOW finish. See Diagram 1.

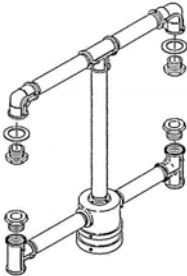
For *dual post-top mount*.

A 1½” aluminum post top signal mounting shall be furnished. It shall consist of a slip fitter for 1- and 2-way signal heads with a 4 inch slip-fitter bracket with a set screw, a lower mounting assembly, a support tube, and an upper mounting assembly. This mounting assembly should be Pelco Product Part Number SE-3257 or equivalent with a FEDERAL YELLOW finish. See Diagram 2.

**Diagram 1.
Single Post-
Top Mount**



**Diagram 2.
Dual Post-Top
Mount**

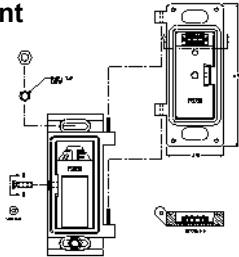


For *side-of-pole mount*.

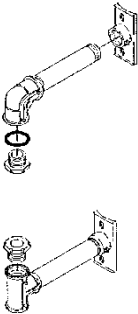
A CLAMSHELL mount shall be furnished, compatible with a 4-1/2 inch and larger pole. The clamshell mount shall be compatible with either bolt mounting (to a wood pole), or band-on mounting to a steel pole. The side-mount shall make provisions for a hinge, and for wiring and terminal block. All hardware shall be tamper resistant. See Diagram 3.

A 1½” aluminum side-of-pole signal mounting shall be furnished. It shall consist of hub plates with conduit openings, and upper and lower arm assemblies for a 1-way signal. This mounting assembly should be Pelco Product Part Number SE-3214 or equivalent with a FEDERAL YELLOW finish. See the Diagram 4.

**Diagram 3.
Clamshell Mount**



**Diagram 4.
Side-of-pole Mount**



Locking devices equivalent to serrated washers shall be furnished with each type of mounting brackets, so that the pedestrian signal heads may be firmly and positively held in their required alignment.

Hand/Man LED Module and Hand/Man COUNTDOWN LED Module

Each LED module supplied shall be factory installed in the pedestrian signal head or shipped as a complete module with weather tight neoprene gasket to retrofit existing SCDOT polycarbonate pedestrian signal heads if applicable. Design the LED pedestrian signal module for installation into

existing standard pedestrian signal head that does not contain the incandescent signal section reflector, lens, egg crate visor, gasket, or socket and requires no other physical modifications to the existing pedestrian signal head.

Identify each module with the manufacturer's name, model number, serial number, date of manufacture, and lot number if applicable per section 3.6 of "The Equipment and Materials Standards" of the Institute of Transportation Engineers "Vehicular Traffic Control Signal Heads" (VTCSH) Part 2, Chapter 2A.

The lens shall be a clear 0.25 inch, non glare, matte finish with a smooth outer surface and UV stabilized to withstand ultraviolet exposure for a minimum period of 60 months without exhibiting evidence of deterioration. Coat the front surface of a polycarbonate lens to make it more abrasion resistant. Ensure that the lens has light transmission properties equal to or greater than 80%.

a) **Optical**

Comply with the following sections: 3.3, 3.5, 3.6, 5.2, 5.3, 5.7, 6.1, 6.3.1, 6.3.3, 6.3.4, 6.4.4, and 6.4.5 of The Equipment and Materials Standards of the INSTITUTE OF TRANSPORTATION ENGINEERS (ITE), "Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Module" (March 2004) unless otherwise specified.

LED Hand/Man Module

Provide **16 inch displays** that have SOLID Symbolic Messages that meet the dimension requirements cited in Chapter 3, Table 1 Symbol Message for Class 3 displays (minimum 11 inches high and 7 inches in width each). The LED hand/Man symbols shall be a side-by-side display. Configure the pedestrian signal module with a sufficient number of LEDs to provide an average luminous intensity of at least 3750 candela per square meter of lighting surface for the "RAISED HAND", and 5300 candela per square meter of lighting surface for the "WALKING MAN". Ensure they meet this average luminous intensity throughout the warranty period over the operating temperature range. Wire the LEDs such that a catastrophic loss or failure of one or more LEDs will result in the loss of not more than five percent of the pedestrian signal module light output.

LED Hand/Man Countdown Module

Provide **16 inch displays** that have SOLID Symbolic Messages that meet the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 3 displays. Ensure that the countdown number display is a minimum of 7 inches high by 6 inches wide. The LED hand/Man symbols shall be an overlay display. Configure the pedestrian signal module with a sufficient number of LEDs to provide an average luminous intensity of at least 3750 candela per square meter of lighting surface for the "RAISED HAND" and "COUNTDOWN", and 5300 candela per square meter of lighting surface for the "WALKING MAN". Ensure they meet this average luminous intensity throughout the warranty period over the operating temperature range. Wire the LEDs such that a catastrophic loss or failure of one or more LEDs will result in the loss of not more than five percent of the pedestrian signal module light output.

Design the countdown display as a double row of LEDs, and ensure the countdown display blanks-out during the initial cycle while it records the countdown time. Ensure that the countdown display is operational only during the flashing don't walk, clearance interval. Blank out the countdown indication after it reaches zero until the beginning of the next flashing don't walk indication, and design the controlling circuitry to prevent the timer from being triggered during the solid hand indication.

Provide *certification* **with the bids** for evaluation that the pedestrian signal module complies with the sections of the ITE specifications identified in section 3.1 above and this specification. Provide **with the bids**, written independent testing laboratory results showing

that the pedestrian signal modules meet or exceed the luminous intensity requirements of sections 3.2 and 3.3 of this specification.

Portland Orange LEDs for the hand and countdown shall be of the latest AlInGaP technology or higher and Lunar White LEDs for the man shall be of the latest InGaN technology or higher.

b) Electrical

Ensure that LED modules are compatible with signal load switches and conflict monitors meeting NEMA Standard TS 1 - 1989. Design the module to provide sufficient current draw to ensure proper load switch operation while the voltage is varied from a regulated 80Vrms to 135Vrms. Provide control circuitry to prevent current flow through the LEDs in the off state to avoid a false indication. Design all modules to meet existing SCDOT monitor specifications for the following types of signal monitors: 170 cabinet/controller compatible SCDOT specified Type 210, Type 2010, Type 2010ECL, and Type 2010ECL-ip conflict monitors (including red monitoring and so-called plus features such as dual indication detection and short yellow time detection).

Provide lead wires that are eighteen gauge (18AWG) minimum copper conductors with 105 degree Celsius insulation. Lead wires shall be a minimum of 30 inches long with NEMA "spade" terminals that are appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in the pedestrian signal head.

The LED's shall be soldered to the circuit board.

Ensure that the power consumption for the pedestrian signal modules is equal to or less than the following in watts.

TEMPERATURE	25°C	74°C
HAND	10	12
MAN	9	12
COUNTDOWN	9	12

Packaging

Each single pedestrian signal head, complete with visor and LED specified, completely assembled and designated mounting assembly, shall be packaged in a separate corrugated cardboard box. It shall be clearly labeled on the END of the box, in English, as to the type of mounting assembly contained therein.

Each style of retrofit module complete with weather tight neoprene gasket shall be packaged in a separate corrugated cardboard box. It shall be clearly labeled on the END of the box, in English.

Certification

Provide **with the bids**, written Certification from the intended Manufacturer, that ITE Standards have been met for heads and modules.

The manufacturer shall have previously supplied indications to other states or cities and shall supply a list of these cities and/or states with the bid. The reference shall include name of city or state, contact person, phone number, and model number of the LED display(s) previously supplied. Failure to submit references upon request shall be grounds for refection of the bid.

The Vendor SHALL FURNISH, the design details and drawings in sufficient detail for complete evaluation of the Proposal, and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing at that time.

Sample modules shall be provided for Department approval upon request. The sample modules submitted shall be representative of typical average production units. **Samples will not be returned unless requested by the vendor.**

NOTE: CATALOG CUTS ARE REQUIRED.

Warranty

During the period of **24 months** following the date of ACCEPTANCE, the Manufacturer or Vendor shall replace, at no expense to the Department (including shipping costs), any part of Polycarbonate Pedestrian Signal Head that fails by reason of defective material or workmanship.

Performance shall be warranted for a period of **60 months** of the date of installation and shall include repair or replacement of an LED pedestrian module that exhibits light output degradation which in the judgment of the department, cannot be easily seen at 150 feet in bright sunlight with the visor on the housing or that drops below the luminous intensity output requirements of sections 3.2 and 3.3 of this specification. Failure due to workmanship, materials, and manufacturing defects shall be warranted for repair or replacement of the first 60 months of the date of installation. The vendor shall replace any failed modules within 30 calendar days of notification.

Construction

Location

Pedestrian signal heads shall be installed where shown on the Plans or at other locations as directed or permitted by the RCE.

Pedestrian signal heads mounted on the same pole or pedestal, shall be within 6 inches of being the same height unless otherwise specified on the Plans.

a) Clearance

Pedestrian signal heads shall be mounted so that no portion of the assembly is closer than 18 inches to the face of the curb.

Pedestrian signal heads mounted on poles or pedestals shall be mounted to provide a clearance of 10 feet from the surface grade.

b) Wiring

Electrical cable shall be connected to the terminals in each signal head to provide the proper display indication when energized by the signal controller.

External splicing of cables shall not be permitted.

Electrical cable runs shall be as indicated in Design Details, the Wiring Diagram, or as shown on the Plans.

c) Hardware

All hardware is to be non-corrosive material.

All brackets, arms, and other hardware shall be painted FEDERAL YELLOW, or as directed by the RCE.

d) Mounting

All pedestrian signal heads shall be mounted as shown on the Design Details, the Standards, or the Plans.

Measurement

The furnishing and installing of pedestrian signal heads shall be measured by EACH type of head assembly and/or mounting method specified, including ALL internal electrical connections and all required incidental hardware.

The furnishing and installing of pedestrian LED modules shall be measured by EACH.

Payment

Installing and/or furnishing pedestrian signal heads, measured as provided above, will be paid at the contract unit price for:

INSTALL 1-WAY, 1 -SECTION PEDESTRIAN SIGNAL HEAD – EACH
FURNISH AND INSTALL 1-WAY, 1 -SECTION PEDESTRIAN SIGNAL HEAD – EACH

(1 / 2)-WAY, 1 -SECTION PEDESTRIAN SIGNAL HEAD W/LED MODULE -- EACH

PEDESTRIAN TRAFFIC SIGNAL MOUNTING ASSEMBLY FOR SIDE POLE -- EACH
PEDESTRIAN TRAFFIC SIGNAL MOUNTING ASSEMBLY FOR POST TOP -- EACH

Furnishing and Installing pedestrian LED modules, measured as provided above, will be paid at the contract unit price for:

INSTALL PEDESTRIAN LED MODULE – EACH
FURNISH AND INSTALL PEDESTRIAN LED MODULE – EACH

and such payment shall be full compensation for installing/furnishing and installing the specified equipment signal head, aiming, electrical connections, and for all necessary hardware and incidentals.

FURNISH AND INSTALL PEDESTRIAN PUSH BUTTON STATION ASSEMBLY WITH SIGN

Description

This item consists of installing and/or furnishing AMERICAN DISABILITIES ACT APPROVED ALUMINUM PEDESTRIAN PUSH BUTTON STATION ASSEMBLIES AND PUSH BUTTON SIGNS, of the types, sizes, and mountings specified in accordance with these Specifications or and at locations shown on the Plans or as established by the RCE.

Materials

Aluminum Push Button Station Assemblies

Each aluminum push button station assembly shall conform to the specifications as set forth by the AMERICAN DISABILITIES ACT (ADA). Each aluminum push button station assembly shall be provided with an adjoining sign and must be able to accommodate to the size of the specified sign (either 9 x 12 inch or 9 x 15 inch).

Push Buttons (with or without adjoining sign)

The long life switch shall be actuated by a 2 inch diameter chrome plated button and shall be included into a vandal resistant one-piece cast aluminum assembly and include a cable guide. All/any exposed screws on the push button station assembly shall be stainless steel or other rust resistant material, and be tamper-proof. There shall be no sharp edges.

Finish

The finish color shall be FEDERAL YELLOW (13538) for the aluminum push button station assembly
The push button shall operate on a circuit not to exceed 24 Volts.

Push Button Signs

Each aluminum push button station assembly shall be provided with an adjoining sign.

The push button sign shall be aluminum with minimum thickness of 0.1 inch, with rounded corners, and have a legend in the colors exactly as they appear in the Manual on Uniform Traffic Control Devices for Streets and Highways (2003 Edition).

The signs shall be 9 x 12 inch for:

R10-3 "PUSH BUTTON FOR GREEN LIGHT" when used without Pedestrian Signal Heads (see diagram below)

R10-3b "TO CROSS PUSH BUTTON (MAN WALK SYMBOL W/DEFINITIONS) ← → (arrow-left/right)" when used with hand/man Pedestrian Signal Heads The sign shall be reversible, such that one side displays the message with a left arrow and the other side displays the message with a right arrow (see diagram below).



R10-3



R10-3b

or should be 9 x 15 inch for:

R10-3e "TO CROSS PUSH BUTTON (COUNTDOWN)" when used with countdown Pedestrian Signal Heads The sign shall be reversible, such that one side displays the message with a left arrow and the other side displays the message with a right arrow (see diagram below).



R10-3e

Certification

Provide **with the bids**, written Certification from the intended Manufacturer, that ADA SPECIFICATIONS have been met for push buttons.

Provide **with the bids**, design details and drawings sufficiently detailed. This is necessary for a complete evaluation of the Proposal, and comparison with these Specifications. Any exceptions to these Specifications must be stated in writing at that time.

NOTE: CATALOG CUTS ARE REQUIRED.

The low Bidder shall submit for approval, one sample of the aluminum pedestrian push button station assembly to be furnished, if requested by the Department. Failure to submit a sample when requested will result in disqualification of bid.

Construction

Push Button Station Assembly

Push button station assemblies shall be installed where shown on the Plans, or as directed by the RCE.

Push button station assemblies placed on poles shall be at a height of 3-1/2 to 4 feet ABOVE GRADE.

The push button and sign shall be oriented and wired in such a manner to clearly indicate to the pedestrian, the crosswalk with which it is associated.

Push button station assemblies shall be attached to poles using 1 inch stainless steel bands or galvanized screwed directly to pole. The finished assembly shall be very firmly mounted.

On metal poles, the cable for the push buttons shall be brought through the rear of the assembly directly into the pole or controller cabinet. On wooden poles electrical conduit shall be used.

Each push button station assembly shall be connected with the appropriate electrical cable, and wired to actuate the proper phase of the controller. The necessary cable is specified as a separate item. (See FURNISH AND INSTALL ELECTRICAL CABLE). The cable shall not be spliced.

Push Button Signs

Each push button sign shall be installed on the station assembly and reflect the proper intention of the pedestrian movement.

Measurement

Furnishing and installing pedestrian push buttons and signs shall be measured by each unit, in place, including all incidental hardware and making electrical connections.

Payment

Installing and/or furnishing pedestrian push button station assembly and sign, measured as provided above, will be paid for at the contract unit price bid for:

INSTALL PEDESTRIAN PUSH BUTTON STATION ASSEMBLY W/ SIGN – EACH
FURNISH AND INSTALL PEDESTRIAN PUSH BUTTON STATION ASSEMBLY WITH SIGN –
EACH

SIGN R10-3 (PUSH BUTTON FOR GREEN LIGHT) -- EACH

SIGN R10-3b ([MAN WALK SYMBOL W/DEFINITIONS] TO CROSS PUSH - ARROW LEFT) -- EACH

SIGN R10-3b ([MAN WALK SYMBOL W/DEFINITIONS] TO CROSS PUSH - ARROW RIGHT) – EACH

which shall be full compensation for installing/furnishing installing all materials including all labor and incidentals necessary to complete the work as specified.

REMOVAL SALVAGE AND DISPOSAL OF EQUIPMENT AND MATERIALS

DESCRIPTION - This item consists of the Removal and Salvage, or the Removal and Disposal of equipment and materials, during the construction of this project. Construction includes new installations, and the modification, or removal of existing traffic signals. When the Project is within city limits, the local SC DOT District Shop shall be given first right of refusal. If the equipment is declined, it shall next be offered to the City. If also declined, it shall be Disposed of, as stated below.

1. GENERAL -1.1 Removal and Salvage -

These items are to be carefully removed from the job site, salvaged, and returned to the Department. The items of major equipment to be salvaged are listed on the Plans. The Contractor shall deliver, (and obtain a RECEIPT for), the salvaged equipment, to:

**** SC DOT DISTRICT ELECTRICAL/SIGNAL SHOP ****

District 1: 1400 Shop Road, P.O. Box 191, Columbia, SC 29202
(803)-737-6646

District 2: P.O. Box 820, Greenwood, SC 29648
(864)-227-6701

District 3: 13 Saluda Dam Road, Greenville, SC 29611
(864)-241-1117

District 4: 300 Armory Road, P.O. Box 386, Chester, SC 29706
(803)-581-8551

District 5: RT 76/301 E., Palmetto Street, Florence, SC 29503
(843)-661-4733

District 6: 6355 Fain Street, North Charleston, SC 29418
(843)-740-1668

District 7: P.O. Box 1086, Orangeburg, SC 29115
(803)-531-6870

1.2 Disposal -

Material NOT to be salvaged, shall be removed from the job site, become the property of the Contractor; and should be properly disposed by the Contractor, at an APPROVED LAND FILL (or material reclamation yard). Any materials designated as HAZARDOUS WASTE shall be disposed in accordance with regulations enforced by the SC Department of Health and Environmental Control (DHEC), Bureau of Solid and HAZARDOUS Waste; (803)-734-5000 for information.

1.3 Inspection -

Removal and disposal quantities will not be measured as pay items, but shall be included in the price bid for Removal, Salvage, and Disposal. FINAL ACCEPTANCE and Final Payment will be withheld, if the Contractor has not removed unneeded equipment from the job site, and if the Contractor cannot present RECEIPTS from the Shop showing that the salvaged equipment has been delivered to the Department as specified.

1.4 Holes -

Every hole caused by removing old equipment shall be filled THE SAME DAY. It shall be back-filled, compacted, and reseeded/sodded, to the satisfaction of the Engineer. Holes in PAVEMENT shall be cleanly side-trimmed, then brought to grade and finished with the same paving material as the adjacent pavement. Sidewalk "squares" shall be completely replaced (complete square), using forms and expansion material.

2. SPECIFIC ITEMS -2.1 Controllers and Cabinets -

Prior to removal, every cabinet, controller, coordination unit, conflict monitor, detector amplifier, and other major equipment item shall be clearly tagged with the intersection name from which it is being removed. Then, each piece of equipment shall be carefully removed from the cabinet and boxed. The pins and threaded portion of the connectors, shall be protected with plastic covers, or the harnesses left in place to prevent damage. The cabinet with all other related equipment (clocks, flashers, load switches, etc.) may then be removed and transported intact. The foundations of ground mounted cabinets shall be removed completely, or cleared to 0.3 metres (1 ft.) below ground.

2.2 Signal Heads -

Vehicle and pedestrian traffic signal heads to be removed and salvaged shall be carefully dismantled, keeping as much of the hardware intact as possible. During the removal and delivery, special care should be taken to prevent damage to the lenses and visors.

2.3 Metal Poles -

This includes the removal and salvage of strain poles, pedestal poles, and their related hardware (pole caps, bolt covers, handhole covers, nuts, transformer bases, etc.). The pole foundations shall be removed completely, or cleared to 0.3 metres (1 ft.) below ground.

Where shown on the Plans, some pole or cabinet foundations may be designated for complete removal (road widening, etc.). In these cases the concrete base shall be loosened, pulled out of the hole, and disposed.

2.4 Wood Poles -

Wood Poles that are not utilized in the new signalization, and are not required by other utilities, shall be removed. The Engineer shall make the determination whether each wooden pole shall be salvaged or disposed. Back guys, grounding systems, and miscellaneous hardware shall be disposed.

2.5 Pressure Sensitive Detectors -

This includes the removal and disposal of pressure sensitive detector pads and frames. The removal of the adjacent paving and the subsequent back-filling shall be performed as described in the "Trenching and Backfilling" section of FURNISH AND INSTALL ELECTRICAL CONDUIT. Furnishing all materials, providing steel plates during curing, as well as the labor and equipment costs are to be included in the bid price for Removal, Salvage, and Disposal. The removed pressure pad, etc. shall be discarded.

2.6 Miscellaneous Equipment -

Minor equipment shall be removed from the site and discarded. This includes steel cable, electrical cable, conduit, pedestrian buttons and signs, concrete pads, and spliceboxes/pullboxes/handboxes not utilized in the new signalization. Underground conduit and detector loops not utilized, shall be abandoned in place.

2.7 Signs -

Highway signs on existing span wires, shall be removed and salvaged, immediately after the replacement signs have been installed.

3. METHOD OF MEASUREMENT -

The Removal, Salvage, and Disposal of traffic signal materials and related equipment, will not be measured, but shall be paid as a Lump Sum item covering all intersections named in the Contract. The related costs of transportation, disposal, concrete, pavement repair, etc., will not be measured for payment, but shall be included in the bid price of Removal, Salvage, and Disposal.

4. BASIS OF PAYMENT -

The Removal, Salvage, and Disposal of equipment and materials, shall be paid at the Contract price bid for--

REMOVAL, SALVAGE, AND DISPOSAL OF EXISTING TRAFFIC SIGNAL EQUIPMENT-- LUMP SUM

which shall be full compensation for the removal, salvage, and disposal, with transportation, and for all labor, equipment, materials and incidentals to perform the work as specified.

FURNISH SYSTEM INTEGRATION AND TESTING

DESCRIPTION - This work consists of providing the personnel, equipment and technical support to test the traffic signal equipment prior to installation on the street; and to connect all equipment; to program operating parameters; and to make the traffic signal system totally operational.

1. GENERAL -

1.1 Personnel - THIS IS A "TURN-KEY" PROJECT, WITH THE CONTRACTOR PERFORMING -ALL- ACTIVITIES. The CONTRACTOR shall be capable of performing, or shall obtain the services of a MANUFACTURER'S TECHNICAL REPRESENTATIVE, (or other technically trained persons) to accomplish all items in this Specification. Department personnel will NOT perform this service for the Contractor.

1.2 License - Being a third party, it is the responsibility of the CONTRACTOR TO SECURE THE SOFTWARE LICENSE to permit legitimate Contractor use of the firmware and software used by the system. This LICENSE may be written to include training for Contractor personnel.

2. SYSTEM INTEGRATION -

2.1 Installation, Assembly, and Connection -

The CONTRACTOR or MANUFACTURER'S TECHNICAL REPRESENTATIVE, shall provide complete Closed Loop SYSTEM INTEGRATION. This shall include connecting all signal equipment and making it totally operational. This shall also include verification of communication and closed loop operation from the Central Monitoring Facility computer. Where the computer is being provided by the signal system project, this shall include assembly and connection of the computer and peripheral equipment.

2.2 Programming - The CONTRACTOR or MANUFACTURER'S TECHNICAL REPRESENTATIVE shall program the central computer, controllers and master(s) with their associated operating/timing parameters. The initial timing values will be provided as design requires. This work shall include the primary programming of "traffic responsive" parameters, where applicable. These persons shall create and furnish the customized COLOR GRAPHICS DISPLAYS required by the system. This shall include an intersection DRAWING/GRAPHIC for each signal and creating system display(s) for the signals controlled by each separate field master.

3. SYSTEM TESTING -

The CONTRACTOR or MANUFACTURER'S TECHNICAL REPRESENTATIVE shall provide pre-installation cabinet and controller TESTING in accordance with these requirements. The tests shall provide full hookup electrical testing and communication verification. The test period shall extend uninterrupted for (7) seven days for a signal system and (3) three days for an isolated signal or group of signals that will NOT be interconnected in any way. These tests shall be conducted in a climate controlled (indoor /heat /AC) TEST BUILDING, that is provided by the CONTRACTOR. The Building shall be complete with desk, chairs, two telephone lines, 120 VAC outlets, overhead lighting, a rest room, and at a convenient location to be approved by the Department. The TEST BUILDING shall be open to the Department, the Municipality, or the Federal Highway Administration and the test shall be witnessed by the Department. This shall also include storage until the equipment is needed on the street. The certified equipment shall then be transported to work site by the CONTRACTOR.

4. BASIS OF PAYMENT -

All costs associated with these programming, testing, and systems integration activities, and with securing the software License, making the entire system complete and operational to the satisfaction of the Engineer shall be paid at the Contract Unit Price bid for--

INTEGRATION -- LUMP SUM

Which shall be paid on a prorated LUMP SUM basis, being:

- Twenty five (25%) percent with the first monthly estimate;
- Fifty (50%) percent when the contract dollar amount reaches fifty percent of the total contract; and the final
- Twenty five (25%) percent following successful FINAL INSPECTION and conditional acceptance of the traffic signal project, (or of the traffic signal equipment alone, when it is part of a road project).

FURNISH TRAFFIC SIGNAL SYSTEM TRAINING**1. GENERAL REQUIREMENTS -**

The **CONTRACTOR** shall provide complete training for **DEPARTMENT** and maintaining agency personnel and representatives in the operation and maintenance of the traffic signal system components. The training program shall consist of formal classroom lectures and "hands-on" workshops with central and field equipment. The **CONTRACTOR** shall provide all personnel and instructors necessary for providing all training. Where appropriate, the instructors shall be employees of the manufacturer(s) of the traffic signal system components.

All training classes must be completed prior to the beginning of any system/intersection operational testing. Training classes shall not overlap without prior approval of the Resident Construction Engineer. Training class schedules shall be consistent with the working schedules of the class attendees. Training shall only be scheduled on weekdays; and training days shall generally consist of six (6) to eight (8) hours.

The **CONTRACTOR** shall develop and provide all necessary training materials, aids, and manuals.

The **CONTRACTOR** shall provide training and training materials for up to 15 people in each training class. The Resident Construction Engineer shall provide a listing of the expected trainees for each training session, when the proposed training materials are approved.

As part of the **CONTRACT** materials submission requirements, the **CONTRACTOR** shall submit for approval copies of all training program subjects, training materials, aids, manuals, class agendas, class schedules (includes dates and times) and training locations. All submission materials must be approved by the Resident Construction Engineer before permission to begin training is given.

2. TRAINING PROGRAM SUBJECTS -

The **CONTRACTOR** shall, as a minimum, provide training on the subjects listed below. The **CONTRACTOR** shall address the theory of operation and the technical and practical aspects of each component. Specific and thorough attention should be afforded to day-to-day operation, programming, testing, fault-diagnosis and repair of each component. Training related to specific hardware components shall include hands-on demonstrations utilizing sample components identical to those components installed in the field. Training on the proper use of specific tools utilized during installation, testing, and maintenance of various system components shall be addressed. Training classes on the following subjects shall be provided. Minimum required class durations are given in parentheses.

2.1 Local Intersection Controller Assemblies -

This subject shall include all pertinent information required for the programming, operation and maintenance of the local intersection controller assemblies. This information shall include diagnostic and repair procedures. This information shall include but shall not be limited to: local intersection controller; conflict monitor; controller cabinet assembly; and, intersection loop detectors. Manual and computer field programming shall be addressed. The **CONTRACTOR** may expect that class attendees will have basic, general knowledge of traffic controller equipment. (8 hours)

2.2 Internal Local Coordinator -

Local -To- On-Street Master Communications.

On-Street Master Assemblies.

On-Street Master -To- Central System Communications.

This subject shall include all pertinent information required for the programming, operation, and maintenance of the on-street traffic signal system components. This information shall include diagnostic and repair procedures. This information shall include but shall not be limited to: internal local coordination unit; on-street master controller unit; and all communication systems and communication hardware including local telemetry units, any radio components, and on-street auto-dial/auto-answer external communications modems. Manual and computer field programming shall be addressed. The

CONTRACTOR shall expect that class attendees will have no previous experience of knowledge regarding this subject. (16 hours)

2.3 Central Control Center Equipment -

This subject shall include all pertinent information required for the operation and maintenance of the Central Control Center Equipment. This information shall include basic operation of the central microcomputer assembly, monitor, printer, and auto-dial/auto answer external communications modem equipment including various diagnostic/trouble-shooting tools available to the computer user. The **CONTRACTOR** shall expect that class attendees will have a basic familiarity with MS-DOS personal computer systems, but no other specific experience or knowledge regarding this subject. (4 hours)

2.4 Traffic Signal System Central Software And Operation -

This subject shall include all pertinent information required for the operation of the traffic signal system and the development of the traffic signal system database. The pertinent information shall include all aspects of operation of the central software programs. This information shall also include complete and thorough training on the system database and the necessary information to be input into the on-street equipment to give the desired on-street operation. This information shall include all local controller programming and operation as it impacts the operation of the local controllers within the system. This information shall include all programming of the local intersection coordination parameters and on-street master controller units for all modes of coordinated system operation. This information shall include all specific system database structure and parameters and the inter-relations between different types of system data. The **CONTRACTOR** shall expect that class attendees will have basic experience and knowledge of local intersection and coordination system timing and operation but shall not expect specific familiarity with the products of the system of the manufacturer being installed. (16 hours)

3. ACCEPTANCE OF TRAINING -

Within 7 calendar days of the completion of each training class, the Resident Construction Engineer shall provide acceptance or non-acceptance of the training program. If the training program is not accepted, the **CONTRACTOR** shall correct the deficiencies in the training program and provide again the necessary class(es) at his expense. Acceptance of system training of each training program subject will be based on the following criteria:

- (a) Thoroughness and completeness of instructional coverage of the training program subject;
- (b) Thoroughness and appropriateness of the training program subject materials, including class demonstration and audio/visual aids, to the instructional coverage; and,
- (c) Class instructor's ability to answer class attendees and clarify training material to the satisfaction of the class attendees.

The DEPARTMENT reserves the right to halt an ongoing class, if that class will clearly not be accepted.

For all training classes that are not acceptable, the Resident Construction Engineer shall provide specific information on which specific training classes are not acceptable and why within 7 calendar days of the completion of each training class. Within 15 calendar days of notification of non-acceptance of the training program, the **CONTRACTOR** shall submit for approval revised training program materials that correct the deficiencies in the non-accepted training classes. These materials shall clearly demonstrate the **CONTRACTOR's** revisions to the training program and shall include a new training program schedule. All of the **CONTRACTOR's** requirements and responsibilities for the original training program shall be borne by the **CONTRACTOR**. Once the revised training program is approved, the **CONTRACTOR** shall again provide the training classes for the original class attendees or specific substitutes for original attendees. The **CONTRACTOR** is only responsible for providing subsequent training classes for those classes that were not accepted as part of the original training program.

4. **PAYMENT FOR TRAINING** -

Training shall be paid for at the Contract price bid for the item established for:

TRAINING -- LUMP SUM

to be paid at the conclusion of the training, which shall be full compensation for the provision of signal system training, including all materials and incidentals to perform the work as specified.

INSTALL DEPARTMENT SUPPLIED EQUIPMENT

DESCRIPTION - This work shall consist of installing equipment that will be supplied by the department, at the locations designated on the Plans, in accordance with the appropriate Specification, and the applicable Design Detail or Standard.

1. MATERIALS -

The Plans and BID or Proposal Forms, state specifically which material will be supplied by the Department. ALL OTHER MATERIALS SHALL BE ASSUMED TO BE FURNISHED BY THE CONTRACTOR. The Contractor should refer to the appropriate "Furnish and Install ..." Specification to determine what other materials will be required to complete the installation. Those materials must be required to complete the installation. Those materials must then meet the physical Specifications stated. The Contractor shall also supply all miscellaneous materials that will result in a complete and acceptable project.

2. CERTIFICATION -

The Contractor shall provide certification that any material they supply for this item will meet the Specifications.

3. GUARANTEE -

For any materials they supply, the Contractor shall furnish the Department with all warranties offered by the manufacturer as normal trade practice.

4. CONSTRUCTION METHODS -

4.1 General - All workmanship and construction methods shall be in accordance with the appropriate Specification and in agreement with the applicable Design Detail or Standards.

4.2 Example - As an example, take the BID item – "INSTALL CONTROLLER BASE-MOUNTED CABINET-- EACH". The Contractor shall then refer to the Specification titled "FURNISH AND INSTALL CONTROLLERS AND CABINET". They shall then furnish any other necessary materials, and shall complete the work needed to result in a finished installation. The Contractor shall also refer to the Plans, and to the Design Details and Standards.

5. METHOD OF MEASUREMENT -

Installation of Department supplied equipment will be measured by SPECIFIED UNITS installed/erected in place as shown on the plans, including miscellaneous materials, fully operable. The Contractor is responsible for picking up the equipment to be supplied, at the appropriate DOT Depot or Shop, and for providing any loading equipment and trailers required. The Specified Units shall be that stated in the "Furnish and Install..." specification.

6. BASIS OF PAYMENT -

Installed Department supplied equipment, accepted and measured as provided above, will be paid for at the contract unit price bid for:

INSTALL – (Equipment Description) – SPECIFIED UNITS

which shall be full compensation for all work and miscellaneous materials necessary to complete the work item specified. Such payment includes the cost of transportation, loading, and unloading, by the Contractor.