
SUPPLEMENTAL TECHNICAL SPECIFICATIONS

SCDOT TRAFFIC SIGNALS

1/1/2021

APPROVED:

Division Administrator

By: _____

FEDERAL HIGHWAY ADMINISTRATION

Traffic Signal Supplemental Technical Specifications

Table of Contents

		Revision Date
675.0	GENERAL PROVISIONS FOR TRAFFIC SIGNALS	1/1/2021
675.1	ELECTRICAL CONDUIT	1/1/2021
677.1	ELECTRICAL CABLE	1/1/2021
677.3	FIBER OPTIC CABLE	1/1/2021
677.4	FIBER INTERCONNECT CENTER	1/1/2021
677.6	FACTORY TERMINATED PATCH PANEL	1/1/2021
677.7	WIRELESS COMMUNICATIONS ASSEMBLY	1/1/2021
678.1	DETECTOR LOOP	1/1/2021
678.2	WIRELESS VEHICLE DETECTION SYSTEM	1/1/2021
680.1	ELECTRIC SERVICE	1/1/2021
680.2	SPLICE BOX/JUNCTION BOX	1/1/2021
682.1	WOOD POLE/BACK GUY ASSEMBLY	1/1/2021
682.3	STEEL CABLE	1/1/2021
682.4	PEDESTRIAN POLE AND BASE	1/1/2021
684.1	BATTERY BACKUP SYSTEM	1/1/2021
686.1	SIGNAL HEADS	1/1/2021
686.3	PEDESTRIAN SIGNAL HEAD	1/1/2021
686.4	PEDESTRIAN PUSH BUTTON STATION ASSEMBLY WITH SIGN	1/1/2021
686.5	LED BLANKOUT SIGN	1/1/2021
688.1	REMOVAL, SALVAGE AND DISPOSAL OF EQUIPMENT AND MATERIALS	1/1/2021
688.2	TEMPORARY ADJUSTMENT OF TRAFFIC SIGNAL EQUIPMENT AND TIMINGS	1/1/2021
688.3	VIDEO DETECTION SYSTEM	1/1/2021
688.4	RADAR DETECTION SYSTEM	1/1/2021
688.5	STEEL STRAIN POLE AND FOUNDATION	1/1/2021
688.6	CONCRETE STRAIN POLE	1/1/2021
688.7	CONTROLLER AND CABINET ASSEMBLY	1/1/2021
688.8	FLASHER CABINET	1/1/2021
688.9	SOLAR POWERED FLASHER ASSEMBLY	1/1/2021
689.1	WORKING CREW WITH EQUIPMENT	1/1/2021
689.3	TRAFFIC SIGNAL SYSTEM TRAINING	1/1/2021
690.1	STEEL POLE WITH MAST ARM	1/1/2021
699.1	SHORT-RANGE RADIO DEVICE DETECTOR SYSTEM	1/1/2021

Supplemental Technical Specification for General Provisions for Traffic Signals

SCDOT Designation: SC-M -675

1.1 Description

1.1.1 General

This specification details the construction method for traffic signals in accordance with the latest edition of the South Carolina Department of Transportation "Standard Specifications for Highway Construction", the SCDOT Standard Traffic Signal Drawings, the latest revision of the "Manual on Uniform Traffic Control Devices for Streets and Highways", the SCDOT Traffic Signal Design Guidelines, and the PLANS.

Unless noted otherwise on the plans or in the Special Provisions this is a "turn-key" project, with the contractor furnishing and installing all equipment, complete and operational to the satisfaction of the Department. The CONTRACTOR shall install the traffic signal(s) to provide a complete modern and operational installation.

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 Specifications, the Standard Drawings, and with the Department. Deviations from the Plans must be approved by the Department.

Prior to the beginning of construction, the CONTRACTOR shall schedule in a "Pre-Construction Conference" at a time and place to be coordinated by the Department. 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.

After the completion of the project, the CONTRACTOR shall furnish to the District Traffic Engineer, three (3) "red-lined" sets of "as-built" plans detailing deviations from the plans and 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.

1.1.2 Maintenance of Operation

Existing traffic signals shall REMAIN IN OPERATION until the new/modified installation has been satisfactorily tested, and placed in operation. The testing shall be accomplished without hazard to the traveling public and while the signal heads are suitably BAGGED WITH BURLAP. All signal heads that are in place but not in use, shall be covered with BURLAP or an alternative approved by the Department. Plastic bags are NOT acceptable.

After approval is received from the Department, the new signal heads shall be switched into service during the controller phase that is 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 shall completely coordinate work between the sub-contractors and shall carefully stage the project to minimize the impact to traffic.

1.1.3 Operation, Maintenance, and Emergency Service

The CONTRACTOR shall be responsible for the operations of all existing and newly installed signals from the "NOTICE TO PROCEED" until final acceptance of the project. This shall include all daily maintenance of signals and any emergencies which may arise. The CONTRACTOR is also responsible and liable for proper and safe operation of the traffic signal(s). Maintenance of signal operations is considered incidental to the pay item "Traffic Control" if a separate pay item is not provided for these activities.

Maintenance of Detection is required for all signals. Detection of Signals identified as Adaptive/Responsive or High Priority in the plans or special provisions must be maintained and will be paid for in accordance with Table 1 of Section 688.2. Detection of Signals not identified as Adaptive/Responsive or High Priority in the plans or special provisions must be maintained and will be paid for in accordance with Table 1 of Section 688.2.

- I. Restriction – The CONTRACTOR shall not change the phasing or other operation of a signalized intersection without Departmental approval.
- II. Procedure – The Contractor and a representative of the Department shall perform a walk thru of all signals to determine if any repairs are needed prior to the Contractor assuming maintenance responsibility. Prior to construction activities that may affect the operation of the signal, the CONTRACTOR shall request the Department's concurrence and the CONTRACTOR shall assume responsibility for operations and maintenance of the traffic signal. This request shall be in writing to the Department and shall have a written response. In the absence of the request, any activity of the CONTRACTOR, which effect the operation of a signal shall be deemed evidence of the CONTRACTOR's assumption of responsibility for the operation and maintenance of the signal. In addition to accepting maintenance responsibility, the CONTRACTOR also assumes financial responsibility for repairs until final acceptance.
- III. New Signals – Signals installed by the CONTRACTOR shall be maintained by the CONTRACTOR until the Department formally accepts the work (see Final Inspection & Final Acceptance).
- IV. Requirement – The CONTRACTOR shall perform EMERGENCY REPAIRS AND SERVICES as required, to ensure continuity of operation of the traffic signal(s) and associated equipment. This shall include re- placement of malfunctioning LED modules.
- V. Technician – The CONTRACTOR shall provide at least one (1) qualified LOCAL signal technician, subject to on-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 Resident Construction Engineer 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.
- VI. Response Time – The CONTRACTOR shall be ON-SITE of the malfunctioning signal for emergency service within 4 hours of notification by SCDOT.
- VII. 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.
- VIII. Time Changes (EST/DST) – As part of Maintenance, the CONTRACTOR shall reset all time clocks to local legal time.
- IX. 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.
- X. 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. In addition the Contractor shall pay liquidated damages to SCDOT in the amount of **ONE THOUSAND, FIVE HUNDRED (\$1,500) DOLLARS FOR EACH OCCASION, FOR EACH DAY (UNTIL CORRECTED).**

1.1.4 Utility Coordination

Prior to the beginning of any construction activities, the CONTRACTOR shall coordinate as necessary with the Utility Company to provide power and any necessary attachment agreements, as well as, ensuring all utilities are identified and avoided during construction.

1.1.5 Contract Schedule

Unless noted otherwise in the *Special Provisions*, the CONTRACTOR shall furnish the Department with a **WEEKLY SCHEDULE** for the **TRAFFIC SIGNAL CONSTRUCTION** work, each Friday, for the **TWO (2) WEEKS** to come, 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.

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.

1.1.6 Permits, Codes, Licenses, and Abilities

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

The prime contractor or subcontractor responsible for the performance of the work 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 at the time work is performed

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 to the District Electrical Supervisor at the preconstruction meeting or before work commences. 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

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.

1.1.7 Integration

Integration will be performed by the Department or local government signal maintenance staff. The CONTRACTOR shall coordinate with the Department to determine project schedule and time frame for integration. The CONTRACTOR shall provide a minimum of two weeks' notice to the Department or local government signal maintenance staff for integration to allow adequate time for delivery of cabinets, controllers, and conflict monitors.

Signal maintainers will contact the Contractor with any issues regarding the provided equipment. The CONTRACTOR will replace deficient equipment within a reasonable time frame and to meet project schedules.

1.1.8 Equipment

The Department will not furnish signal equipment, unless noted otherwise in the Special Provisions or on the Plans.

The Contractor shall furnish all NEW equipment (submittal of invoices required), including incidental items. Used and refurbished equipment or any equipment with less than 80% of the warranty remaining at installation will not be accepted.

To ensure compatibility, any additional equipment required during the life of this contract due to a Change Order or Extra Work, shall be purchased by the CONTRACTOR from the same manufacturer as the original item. When installing equipment such as signal heads or pedestrian equipment, where some existing equipment is being retained, the CONTRACTOR shall provide the same type of equipment for visual compatibility.

The CONTRACTOR shall submit for approval a list of equipment including make, model number, manufacturer serial numbers, warranty information, purchase invoice, and purchase date. Documentation must be submitted for the furnish items required for this contract. At the time of such submission, the CONTRACTOR shall provide a copy of the Transmittal Letter to the Department. The CONTRACTOR shall provide letters from the manufacturers of the cabinet and controller indicating the submitted equipment is on the SCDOT Qualified Product List. All warranties, serial numbers, documentation, and receipts shall be provided with the cabinet assembly and controller delivery.

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 that is not on the SCDOT Qualified Product List. The documents are to be submitted a minimum of TWO WEEKS PRIOR TO INSTALLATION to the Department's Resident Construction Engineer FOR APPROVAL. At the time of such submission, the CONTRACTOR shall provide a copy of the Transmittal Letter to the Resident Construction Engineer.

Equipment substitutions in the life of the contract are only allowed if the contractor can show a valid hardship in remaining with the originally submitted equipment. A valid hardship may include non-availability of type of equipment due to unforeseen delivery or material shortages (contractor ordering equipment late does not apply) and/or vendor going out of business. The Department may allow equipment substitutions for the following reasons:

- The product is determined by the Department to be of better quality than the originally submitted equipment.
- The Contractor is replacing non-QPL items with QPL items or SCDOT Equipment Contract items.
- The equipment is experimental in nature and the Department wants to test it.

The Department will not pay for furnish and/or installation costs of any materials installed without prior approval and acceptance.

1.1.9 Inspection

Quality Acceptance and Inspection is the responsibility of the Department. The Department will designate those individuals responsible for inspection, which may include the District Electrical Supervisor (DES). Also, local government personnel may be involved in the inspection of traffic signals that are part of a signal maintenance agreement with the Department. 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 DEPARTMENT SHALL BE FINAL.

The Department's designated inspector will provide a punch list of outstanding items to be addressed prior to Final Inspection.

1.1.10 Final Inspection and Final Acceptance

The CONTRACTOR shall request a final inspection only after all the punch list items are completed. The CONTRACTOR shall provide a minimum of one week notice prior to the desired date of the final inspection. The Resident Construction Engineer shall receive confirmation from the Contractor forty-eight (48) hours before to the final inspection that the project is on schedule and ready for inspection.

Upon completion of the Final Inspection and correction of any deficiencies, the work will be subject to a sixty (60) day operational test. Any problems that arise during this period must be resolved and a NEW sixty (60) day test period shall begin. The CONTRACTOR remains responsible for the maintenance and repairs of any deficiencies to the signal until Final Acceptance. Final Acceptance occurs after sixty (60) days of faultless operation. All signal equipment and warranties will be transferred to the Department at Final Acceptance. The Department will become responsible for the signal operations and maintenance upon Final Acceptance of the entire project.

1.1.11 Maintenance of Traffic (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 supplemental specifications, the MUTCD, and the Department.

1.2 Mobilization

Section 103.10 and 103.11 of the STANDARD SPECIFICATIONS is amended as indicated below for traffic signal projects.

- Pay Item Number 1031000 Mobilization (LS) includes all the signals and signal related work in the contract.
- Pay Item Number 1031010 Mobilization (EA) will be paid per traffic signal or per ¼ mile for fiber installation (Each).
- These Pay Items include demobilization.

1031000	MOBILIZATION	LS
1031010	MOBILIZATION	EA

The Pay Item Numbers associated with Mobilization of Material addresses payment for using special equipment to move large items furnished by the Department from a location designated by the Department to the project site.

9610021	MOBILIZATION OF MATERIAL PER WORK ORDER, 1-100 MILES FROM LOCATION TO WORKSITE	EA
9610022	MOBILIZATION OF MATERIAL PER WORK ORDER, 101-250 MILES FROM LOCATION TO WORKSITE	EA
9610023	MOBILIZATION OF MATERIAL PER WORK ORDER, 250+ MILES FROM LOCATION TO WORKSITE	EA

1.3 Payment for Materials on Hand

Section 109.7 of the STANDARD SPECIFICATIONS is amended to include the following paragraphs.

When permitted by the Department, 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 unsecured locations either ON- or OFF-SITE. Other items (signal heads, detector amplifiers, controllers, cabinets, etc.) may be stored in a secured/protected location either ON- or OFF-SITE. The equipment shall be labeled SCDOT with the Project Name. Other requirements of Paragraph 109.8 remain applicable. Payment shall be in accordance with the following criteria:

- The Contractor may be paid at FIFTY (50%) PERCENT of the contract unit price of the items and not to exceed the paid invoice amount.
- Only items measured by 'EACH' shall be eligible
- Only items with unit prices exceeding one thousand and five hundred (\$1500) dollars shall be eligible.

Supplemental Technical Specification for

Electrical Conduit

SCDOT Designation: 675.1

1.1 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.

1.2 Materials

- Use rigid, heavy-wall, galvanized steel conduit, meeting the requirements of Federal Specification WW-C-581, and American Standards Association Specifications USAS C-80.1-1966.
- Use sunlight resistant PVC (Polyvinyl chloride) Conduit 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.
- Use SCHEDULE 80 HDPE (High Density Polyethylene) Rolled Conduit.
- Use Flexible Weather-Tight Steel Conduit consisting of flexible single strip, helically wound, interlocking galvanized steel. Ensure the steel conduit is made liquid-tight using an extruded polyvinyl chloride jacket and that it meets the requirements of UL-360.
- Use fittings that are made of the same material and quality as the conduit run, including conduit bodies, 90° bends, weatherheads, elbows, nipples, couplings, and other hardware.
- Use Conduit Junction Boxes that are non-metallic PVC molded junction box with a weather tight screw-down cover, of nominal size 6"W x 6"L x 4"D.
- Use threaded Grounding Bushings 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.
- Use a Pulling Line made of Polypropylene Rope, having a minimum tensile strength of 240 pounds.
- Use Underground Warning Tape that is 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.
- Use minimum 14 Ga. Tracer Wire

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Electrical Conduit.
- Install conduit as Riser, or Underground.
- Install Underground Conduit as Trenched, Bored and Jack or Directional Bored in accordance with the plans and Standard Drawings.
- Concrete used for patching pavement shall be DOT STANDARD SPECIFICATION CLASS X according to Sections 701,702,703, and 704.
- Bituminous Concrete for patching pavement shall be DOT STANDARD SPECIFICATIONS, Section 400 and 403.
- All materials will be subject to inspection for condition by the ENGINEER, just prior to incorporation into the work.
- Use standard bends, elbows, or by bending the steel conduit to make changes in direction of 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.

- Use standard manufactured conduit bodies, condulets, weatherheads, elbows, nipples, tees, reducers, bends, couplings, unions, etc., of the same materials and treatment as the straight conduit, as required throughout the conduit line. Tightly connect all fittings to the conduit. Use a SOLVENT-WELD CEMENT for fitting connections with PVC conduit. Where steel conduit mates PVC, use an adapter coupling and waterproof seal.

1.3.2 *Riser*

- Use nipples 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. Cap future use conduit.
- Attach conduit risers to wood poles; or where specified, to the outside of steel poles. Use stainless steel bands for steel poles. Use conduit clamps/straps and galvanized screws on wood poles. Attachment shall be in accordance with the plans or Standard Drawings. Furnish each Riser with a weatherhead, which shall not be measured.

1.3.3 *Trenched*

- Unless shown otherwise, place conduits at a minimum depth of 18 inches below surface grade, and slope at a minimum rate of 6 inches per 100 feet of length, to a splice box/junction box hole or drain. Clean and swab all conduit runs before installing cables. Use DUCT-SEAL in poles, cabinets, and buildings to seal the opening.
- Where conduit passes under a curb, cut an 'X' in the curb, over the conduit. Where there is no curb, drive a stake in the ground at the end of the conduit to mark its location. Cut an 'X' to indicate the side the conduit enters, where conduit is placed in a signal pole foundation for future use.
- Restore all cuts, trenches, and openings to the original condition. Replace grass surfaces with pre-grown, cut turf (sod), in existing lawns. Rake, seed and fertilize other dirt areas. Replace any damaged trees and shrubs.

1.3.3.1 Trenching (Non-Paved Surface)

- Excavate the trenches 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. Clear the trench of such materials before placing the conduit. No conduit shall be placed prior to inspection by the ENGINEER. Compact the back-fill and restore the surface.

1.3.3.2 Trenching (In Paved Surface)

- Cleanly saw cut trenches across driveways or streets about 6 inches wide. Place the conduit and compact the back-fill. Provide and install the patch 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.

1.3.3.3 Bored and Jack (Pushing)

- If pay item is provided, place steel conduit under existing roadways, driveways, sidewalks or other paved surfaces by Bore and Jack method. Such conduit shall be placed by jacking, boring, pushing, or other means approved by the ENGINEER, without cutting or removing pavement.

1.3.3.4 Trenchless (Directional Bored)

- If pay item is provided, place Schedule 80 PVC or Schedule 80 HDPE conduit under existing roadways, driveways, sidewalks or other paved surfaces by directional bore method. Conduit shall be buried at a minimum of 36 inches. Payment will not be made for damaged or crumpled conduit. An acceptable alternative material can be **SCHEDULE 80 HDPE CONDUIT (TRENCHLESS)**.

1.3.3.5 Placed Before Pouring

- Install PVC conduit w/ Flexible Weather Tight conduit firmly attached to the bottom reinforcement bar mat or to the bottom wire mat, using plastic tie-wraps every 2 feet, at locations where conduit

is placed before concrete placement in a bridge deck. At expansion joints, use 4 feet (typical) of Flexible Weather Tight steel conduit to accommodate movement. Install to NEC standards for concrete structural installations and usage, including any recommended lubricants and sleeves. Plug all conduit ends to prevent concrete penetration. When used on a bridge, provide a splice-box(es) near the center line, and terminate the conduit in hand-boxes at each end.

1.3.3.6 Open Cuts in Roadway

- Open cuts are typically not allowed, and every effort to bore under roadways and driveways shall be attempted. If utility conflicts require open cuts for installation of conduit, and where approved by the Engineer, conduit may be placed in an open cut and open cuts shall be repaired in accordance with the SCDOT Utility Accommodations Policy.

1.4 Measurement

- Electrical Conduit will be measured by LINEAR FEET, 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.
- 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.
- Unless otherwise specified, trenching, back-filling, and patching will NOT be measured for payment.
- If more than one conduit is installed within a directional bore, payment will be made for the directional bore from box to box. The additional runs of conduit will be paid per LF of additional conduit (pay item 675027Z) from box to box.
- F&I Encased Conduit work includes all equipment, manpower and materials to furnish and install conduit in an open cut paved area within a travel way; this work is paid by linear feet (LF):

1.5 Payment

For conduit either Trenched or Riser:

6750005	FURNISH & INSTALL 1.0" GALVANIZED RIGID CONDUIT	LF
6750015	FURNISH & INSTALL 2.0" GALVANIZED RIGID CONDUIT	LF
6750025	FURNISH & INSTALL 3.0" GALVANIZED RIGID CONDUIT	LF
6750181	FURNISH & INSTALL 1.0" ALUMINUM CONDUIT	LF

For bored and jacked:

6750078	FURNISH & INSTALL 1.0" GALVANIZED RIGID CONDUIT (BORED AND JACKED)	LF
6750085	FURNISH & INSTALL 2.0" GALVANIZED RIGID CONDUIT (BORED AND JACKED)	LF
6750090	FURNISH & INSTALL 3.0" GALVANIZED RIGID CONDUIT (BORED AND JACKED)	LF

For high accuracy directional boring:

675027S	FURNISH & INSTALL 2.0" SCHEDULE 80 PVC CONDUIT (DIRECTIONAL BORED)	LF
675027V	FURNISH & INSTALL 3.0" SCHEDULE 80 PVC CONDUIT(DIRECTIONAL BORED)	LF
675027Y	FURNISH & INSTALL 4.0" SCHEDULE 80 PVC CONDUIT(DIRECTIONAL BORED)	LF
675027Z	FURNISH ADDITIONAL CONDUIT WITHIN DIRECTIONAL BORE	LF
6760050	FURNISH & INSTALL 1" SCHEDULE 80 HDPE CONDUIT (TRENCHLESS)	LF

6760060	FURNISH & INSTALL 2" SCHEDULE 80 HDPE CONDUIT (TRENCHLESS)	LF
6760070	FURNISH & INSTALL 3" SCHEDULE 80 HDPE CONDUIT (TRENCHLESS)	LF
6760080	FURNISH & INSTALL 4" SCHEDULE 80 HDPE CONDUIT (TRENCHLESS)	LF

For flexibility:

6750175	FURNISH & INSTALL 1.0" FLEXIBLE GALVANIZED STEEL CONDUIT - WEATHER TIGHT	LF
6750179	FURNISH & INSTALL 2.0" FLEXIBLE GALVANIZED STEEL CONDUIT - WEATHER TIGHT	LF
675017D	FURNISH & INSTALL 3.0" FLEXIBLE GALVANIZED STEEL CONDUIT - WEATHER TIGHT	LF

Open Cut:

6750262	FURNISH & INSTALL ENCASED CONDUIT (2-2" PVC, SCHEDULE 40)	LF
6750263	FURNISH & INSTALL ENCASED CONDUIT (3-2" PVC, SCHEDULE 40)	LF

Supplemental Technical Specification for

Electrical Cable

SCDOT Designation: SC-M -677.1 (6/20)

1.1 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 detailed in the Standard Drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Electrical Cable.

1.3.2 Field Wiring

- Install SPLICE-FREE cable runs. Make all connections at terminal blocks, or in the controller cabinet.
- Install all field wiring 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.
- Provide at least 3 feet of cable slack at each splice box, strain pole base, and cabinet. Neatly coil and bind the slack with a nylon tie.
- At the cabinet end, label each cable, using nylon cable markers, and indelible pen, indicating the Phase and/or Approach (NB, EB, etc.).
- Cabinet connections shall correspond to the COLOR-CODE shown on the Standard Drawings for Electrical Wiring Assignments (677-100-001 to 677-100-004); (green wire to green signal circuit, etc.).
- Replace the entire length of cables damaged during installation, without further cost to the Department.
- All electrical cable installed in conduit shall be drawn in place, free from electrical and mechanical injury. When a lubricating agent is needed, use a wire pulling compound compatible with the cable insulation.
- Install in conduit any vertical cable runs mounted on the outside of poles as shown on the plans or in the Standard Drawings.
- Use weather service heads wherever electrical cable directly enters a strain pole or a vertical conduit run.
- Provide drip loops of at least 8 inches at all overhead entrance points such as signal heads, strain poles, or weather heads.
- If any splices in homerun cables are detected, all work will cease by the contractor in that district until new wire is pulled to replace the spliced joint.

1.3.3 Traffic Signal Wiring Cable

- Install each cable run with the number of conductors indicated in the Standard Drawing 677-100-001 Electrical Wiring Assignment – Signal Heads. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.
- Run a separate cable for each phase or approach in accordance with Standard Drawing 677-100-001 Electrical Cable Wiring Assignment – Signal Heads.
- 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
FYA: To Each Approach	6 pair (12 conductor) BLACK

1.3.4 Loop lead-in Wiring

- Install each cable run with the number of conductors indicated in the Standard Drawing 677-100-004 Electrical Cable Wiring Assignment – Vehicle Detection –Inductance Loops. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.
- Run a separate cable to each corner of the intersection in accordance with Standard Drawing 677-100-004 Electrical Cable Wiring Assignment – Vehicle Detection –Inductance Loops.
- The list below is a guide to general usage--

Loop: To Each Corner	4 pair (8 conductor) GRAY
Loop Lead-in	2 pair (4 conductor) GRAY

1.3.5 Pedestrian Signal Head Wiring

- Install each cable run with the number of conductors indicated in the Standard Drawing 677-100-003 Electrical Cable Wiring Assignment – Pedestrian Heads and Pedestrian Buttons 2. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.
- Run cable for each phase or approach in accordance with Standard Drawing 677-100-002 Electrical Cable Wiring Assignment – Pedestrian Heads and Pedestrian Buttons 1.
- The list below is a guide to general usage--

Option A – For pedestrian heads that reside on separate poles

Pedestrian Signal	2 pair (4 conductor) BLACK
Pedestrian Push Button	2 pair (4 conductor) GRAY

Option B – For pedestrian heads that reside on the same pole

Pedestrian Signal	4 pair (8 conductor) BLACK
Pedestrian Push Button	4 pair (8 conductor) GRAY

1.3.6 Push Button Wiring

- Install each cable run with the number of conductors in accordance with Standard Drawing 677-100-003 Electrical Cable Wiring Assignment – Pedestrian Heads and Pedestrian Buttons 2. These include the provision of spare conductors. The substitution of additional cables to attain the required number of conductors shall not be permitted.

- Run cable for each phase or approach in accordance with Standard Drawing 677-100-002 Electrical Cable Wiring Assignment – Pedestrian Heads and Pedestrian Buttons 1.
- The list below is a guide to general usage--

Option A – For push buttons that reside on separate poles

Pedestrian Push Button 2 pair (4 conductor) GRAY

Option B – For push buttons that reside on the same pole

Pedestrian Push Button 4 pair (8 conductor) GRAY

1.3.7 Electrical Conduit

All conduit and elbows shall be installed as described in the appropriate Specification.

See 675.1 ELECTRICAL CONDUIT.

See 688.7 CONTROLLER AND CABINET ASSEMBLY.

See 688.5 STEEL STRAIN POLE AND FOUNDATION.

1.4 Measurement

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

1.5 Payment

6770388	FURNISH & INSTALL NO. 14 COPPER WIRE, 4 CONDUCTOR - BLACK	LF
6770389	FURNISH & INSTALL NO. 14 COPPER WIRE, 4 CONDUCTOR - GRAY	LF
6770393	FURNISH & INSTALL NO. 14 COPPER WIRE, 8 CONDUCTOR - BLACK	LF
6770394	FURNISH & INSTALL NO. 14 COPPER WIRE, 8 CONDUCTOR - GRAY	LF
	FURNISH & INSTALL NO. 14 COPPER WIRE, 12 CONDUCTOR - BLACK	LF

Supplemental Technical Specification for

Fiber Optic Cable

SCDOT Designation: 677.3

1.1 Description

This work shall consist of furnishing and installing single-mode fiber optic (SMFO) cable in conduit and risers or overhead lashed to new messenger cable.

1.2 Materials

Acceptable single-mode fiber optic (SMFO) cable shall meet all requirements stated in RUS-90 and 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. More information concerning these industry standards can be found on the SCDOT website, *677.3 Fiber Optic Cable Industry Standards*, http://www.scdot.org/doing/publications_Traffic.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Fiber Optic Cable.
- The CONTRACTOR shall furnish all materials and attachment hardware and installation guides necessary to install the fiber optic cable in accordance with Standard Drawings 677-300-01 Communications – Overhead Fiber Interconnect and 677-300-02 Communications – Underground Fiber Interconnect. Install fiber optic cable where, and in the manner indicated on the Plans, or as needed to maintain communications in an existing fiber network, in accordance with the standard drawings.
- The CONTRACTOR shall order cable in reel lengths that are of sufficient length to require no intermediate splicing of the cable.
- Prior to installation, the CONTRACTOR SHALL PROVIDE certified TEST RESULTS from the manufacturer showing the cable furnished has been tested and meets Industry Standards, 677.3 Fiber Optic Cable.
- The CONTRACTOR shall take every precaution to ensure the fiber optic cable is not damaged during storage and installation. Do not step on the fiber optic cable or run over the fiber optic cable by any vehicle or equipment. Do not pull the fiber optic cable along the ground or over or around obstructions.
- Ensure the fiber optic cable is packaged on wooden reels. These reels shall not contain imperfections such as broken flanges or nails that may cause damage to the cable as it is unreeled.
- Each cable reel shall have a durable weatherproof label that shows the actual length of cable on the reel.
- The CONTRACTOR shall coordinate his overhead and underground construction activities

on a continuing basis with each of the utility agencies which have facilities in the immediate vicinity.

1.3.2 Bends and Tensioning

- 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 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, use the “figure-eight” configuration 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 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 ENGINEER. 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.

1.3.3 Aerial Installation

- Where the plans call for aerial installation, the CONTRACTOR shall furnish new messenger cable (see 682.3 Steel Cable) and shall lash the fiber optic cable to the new messenger.

- Install aerial cable 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 ENGINEER 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.
- Maintain the required clearances between the fiber optic cable and the utility features as follows unless otherwise noted on the PLANS:
 - 4 inches minimum vertical clearance and 12 inches minimum total (diagonal) separation to the telephone and/or cable vision facilities.
 - 40 inches minimum vertical clearance to all electrical transformers.
 - 40 inches minimum vertical clearance to all electric lines (including street light circuits).
- Where called for on the PLANS or as directed by the ENGINEER, furnish fiberglass extension arms and utilize to install the new fiber optic cable. Provide MIF PH6-2 fiberglass extension arms or approved equal.
- Where called for on the PLANS, the CONTRACTOR shall install down guys, sidewalk guys, and aerial guys in accordance with 682.2 Back Guy and as shown in the standard drawings.
- 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. Form drip loops by hand or by using an expansion loop-forming tool. Support the cable with straps and spacers in the absence of lashing wire support and to hold the cable bundles together. Install the strap and spacer no closer than 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 inch 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.
- Over lash the fiber optic cable to the messenger cable (See 682.3 Steel Cable - 1/4" galvanized steel cable). Use aluminum wrapping tape spaced at intervals not exceeding 380 mm or with 1.5 mm (minimum) diameter galvanized steel spiral cable wrap for lashing. Wrapping tape, if used shall be 1.3 mm x 7.6 mm. Use at least 4 turns. Accomplish the lashing in the manner that results in the wire and the cable appearing to be an integral part of the support cable. Install fiber optic cable 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. Terminate the lashing wires as follows:
 - 1) Place a cable spacer between the fiber optic cable and the messenger.
 - 2) Locate lashing wire clamp 2 inches from strap and spacer. Pull enough lashing wire out of lasher to terminate into the lashing wire clamp.
 - 3) Wrap the lashing wire 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.
 - 4) Secure the lashing wire as shown in the typical details.

1.3.4 Underground Installation

Where shown on the PLANS, install the fiber optic cable 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 ENGINEER with 4 copies of the cable manufacturer's

recommended and maximum pulling tensions and a list of the cable manufacturer's approved pulling lubricants. Only use those lubricants in the quantity recommended by the fiber optic cable manufacturer.

- 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, use a dynamometer (clutch device) approved by the ENGINEER 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. Use approved cable guides, feeders, shoes and bushings to prevent damage to the cable during installation.
- Use sealing bushings rather than weather heads on all risers containing fiber optic cable. The sealing bushings shall conform to the typical detail shown.
- Ensure conduit bends and cabinet entrance fittings used by the fiber optic cable network are designed to accommodate the bending radius limitations of the fiber optic cable used.

1.3.5 Splice

Splice the fiber optic cable only at those points shown in the PLANS. The designated splices proposed for installation in each controller cabinet consist of one of the following:

- Fibers Interconnect Centers – This splice in the cabinet shall be installed in accordance with 677.4 Fiber Interconnect Center
- The CONTRACTOR shall pull an adequate amount of fiber optic cable into the controller cabinet to perform splicing and to provide approximately 50 feet of slack cable (approximately 25 feet from the entering and 25 feet 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.
- Factory Terminated Patch Panel – This aerial splice and plug into cabinet shall be installed in accordance with 677.6 Factory Terminated Patch Panel
- Fiber optic cable runs shall be continuous between allowable 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, or pull boxes shall not be permitted.

1.3.6 Utilities

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

1.3.7 Grounding and Bonding

- All metal conduits 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. Use #6 AWG bare stranded copper wires for the grounding or bonding conductor.
- 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.

1.3.8 Fiber Optic Cable Tests

- 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 ENGINEER.
- Contractor shall provide documentation indicating that all optic fibers have been proof tested by the fiber manufacturer at a minimum load of 50 kpsi.
- Contractor to provide documentation that all optical fibers have been 100% attenuation tested by the manufacturer. The attenuation of each fiber shall be provided with each cable reel.
- 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 ENGINEER 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.
- 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.
- 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 ENGINEER 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.

1.4 Measurement

- Fiber optic cable, of the type and size specified will be measured by linear feet of cable actually furnished and installed, completely in place and accepted, using an "OTDR" (optical time-domain reflectometer). 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.
- Note that electrical conduit, splice boxes, splice cabinets, and steel span wire are listed elsewhere as separate pay items.

1.5 Payment

6770470	FURNISH & INSTALL 12 STRAND FIBER OPTIC CABLE – SINGLE MODE	LF
677046D	FURNISH & INSTALL SELF SUPPORTING 12 STRAND FIBER OPTIC CABLE - SINGLE MODE	LF

Supplemental Technical Specification for

Fiber Interconnect Centers

SCDOT Designation: 677.4

1.1 Description

This work shall consist of furnishing and installing a Fiber Interconnect Center, including splicing the fiber optic cable and all necessary material to accomplish this work in accordance with this specification and standard drawings.

1.2 Materials

The Fiber Interconnect Center shall include ST adapter panel, strain relief hardware, be rack mountable, have the capacity for 4 Fusion Splice Trays and termination/connection capacity for 24 fibers in 4 modules. The Center shall be a Systimax 600G2-1U-UP-SD or approved equivalent.

The interconnect center shall be equipped with 2 fiber optic modular connector panels with 24 factory-installed interconnection sleeves. The modular 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. These shall be Systimax MODG2-6ST-SM-PT-A and MODG2-6ST-SM-PT-B or approved equivalent.

Each interconnect center shall be furnished with 3 Fusion Splice Trays. The trays shall be capable of accepting 12 fusion and 6 mechanical splices. The tray shall be a Systimax RS-2AF-16SS or approved equivalent.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Fiber Interconnect Center.
- Multiple splices may be required to connect all incoming fibers to traffic signal network.

1.3.2 Cabinet

- Install the Fiber Interconnect Center in the controller cabinet. Place the Fiber Interconnect Center in the cabinet such that the slack fiber optic cable stored on top of the fiber interconnect center (in accordance with 677.3 Fiber Optic Cable) can be easily removed (along with the fiber interconnect center) from the cabinet and taken to a maintenance vehicle for splicing.
- Provide all necessary materials and hardware including furnishing and installing splice trays, interconnection sleeves, jumpers, and connectors needed for connecting the fiber optic cable to the signal communications network.

1.3.3 Splicing Methods

- Use the fusion-splice technique to perform all splicing, which induces less than 0.3 dB attenuation, unless noted otherwise in the special provisions. Recoat bare fibers 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. Package each spliced fiber in a heat shrink protective sleeve or housing. Perform all splices 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.

- Provide incoming fibers with 5 feet of coiled slack and splice to a pigtail of the same type fiber. Pigtails shall have a minimum length of 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.
- Protect unused optical fibers with sealed end caps.
- The CONTRACTOR shall record the meter marks on the cable sheath at each splice point. Provide these marks to the Engineer as part of the as-built system plans at the completion of the project.

1.3.4 Jumpers

- The CONTRACTOR shall furnish and install 2 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.

1.3.5 Future Applications

- The fiber optic communications network shall accommodate future applications. As shown in the standard drawings, fusion splice all six fibers in one buffer tube of the entering cable through to the six fibers in one of the buffer tubes leaving the cabinet. Maintain the continuity of the buffer tube and fiber color. Splice these fibers in a separate splice tray. The cable entering and exiting the cabinet will contain another buffer tube that contains six fibers. Fusion-splice three of the incoming and three of the outgoing fibers to pigtail assemblies with factory-installed type ST compatible connectors. Place these six splices in a second splice tray. Fusion-splice the remaining three incoming and three outgoing fibers to pigtail assemblies with factory-installed type ST compatible connectors and placed in a third tray. Connect all pigtail assemblies to the connector panels installed in the Fiber Interconnect Center. Clearly label the Transmit and Receive designations of each fiber pair on the front of the connector panel. Test each fiber termination/connection for attenuation.

1.3.6 Fiber Optic Cable Tests

- 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). Conduct the test while the fiber is still on the reel and provide the test results to the ENGINEER.
- 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 ENGINEER 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.
- 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. Replace any connector/end splice with a loss greater than 0.7 dB. Test any replacement connectors/ends.
- 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 ENGINEER 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.

1.4 Measurement

- This item shall include the labor, equipment, and materials necessary to furnish and install the fiber optic interconnect centers in accordance with the PLANS and Standard Drawings. This item shall

be measured by the number of each installed, which shall be full compensation for furnishing and installing 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.

- Pay item 6770486 may be used to pay for additional fiber splices required if more than one fiber trunk is to be interconnected at signal. This pay item includes all necessary items needed to provide this interconnection.

1.5 Payment

6770476	FURNISH & INSTALL FIBER OPTIC INTERCONNECT CENTER	EA
6888092	INSTALL FIBER OPTIC INTERCONNECT CENTER	EA
6770486	FIBER OPTIC REPAIR SPLICE OH/UG	EA

Supplemental Technical Specification for Factory Terminated Patch Panel

SCDOT Designation: 677.6

1.1 Description

This work shall consist of furnishing and installing a Factory Terminated Patch Panel, including splicing the fiber optic cable and all necessary material to accomplish this work in accordance with this specification and standard drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Factory Terminated Patch Panel.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.
- Multiple splices may be required to connect all incoming fibers to traffic signal network.

1.3.2 Cabinet

- The factory terminated patch panel shall be installed by the CONTRACTOR between the controller cabinet and the overhead fiber optic cable run. The factory terminated patch panel shall be located in the cabinet such that the slack fiber optic cable is safely stored (in accordance with 677.3 Fiber Optic Cable).
- Provide all necessary materials and hardware including furnishing and installing interconnection sleeves, jumpers, and connectors needed for connecting the fiber optic cable to the signal communications network.

1.3.3 Splicing Methods

- When using a preterminated, molded patch panel unit that serves as the drop cable and fiber interconnect center (patch panel/fusion splice containment) the free end shall be spliced to the trunk fiber optic cable in an approved aerial enclosure according to the splice plan. The overhead splice and enclosure and all necessary materials and hardware is incidental and should be included in pay item.
- Use the fusion- splice technique to perform all splicing, which induces less than 0.3 dB attenuation, unless noted otherwise in the special provisions. Recoat bare fibers 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. Package each spliced fiber in a heat shrink protective sleeve or housing. Perform all splices 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.
- Protect unused optical fibers with sealed end caps.

- The CONTRACTOR shall record the meter marks on the cable sheath at each splice point. Provide these marks to the Engineer as part of the as-built system plans at the completion of the project.

1.3.4 Jumpers

- The CONTRACTOR shall furnish and install 2 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 Factory terminated patch panel. These jumpers will not be paid for directly but shall be considered incidental to the item Furnish and Install Factory terminated patch panel.

1.3.5 Future Applications

- Splice all fiber strands and connect to accommodate future applications.

1.3.6 Fiber Optic Cable Tests

- 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). Conduct the test while the fiber is still on the reel and provide the test results to the ENGINEER.
- 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 ENGINEER 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.
- 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. Replace any connector/end splice with a loss greater than 0.7 dB. Test any replacement connectors/ends.
- 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 ENGINEER 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.

1.4 Measurement

- The bid for the Factory terminated patch panel shall include the cost of furnishing and installing the Factory terminated patch panel into the signal controller cabinets, splicing into fiber trunk overhead and making all the necessary connections.
- The fusion splicing of the cable, pigtail assemblies, connector panels and interconnection sleeves shall be considered incidental to this item and will not be paid directly.
- This item shall include the labor, equipment, and materials necessary to install the Factory terminated patch panel in accordance with the PLANS and Project Special Provisions. This item shall be measured by the number of each installed.
- Pay item 6770486 may be used to pay for additional fiber splices required if more than one fiber trunk is to be interconnected at signal. This pay item includes all necessary items needed to provide this interconnection.

1.5 Payment

6888082	FURNISH & INSTALL FACTORY TERMINATED PATCH PANEL	EA
6888093	INSTALL FACTORY TERMINATED PATCH PANEL	EA
6770486	FIBER OPTIC REPAIR SPLICE OH/UG	EA

Supplemental Technical Specification for

Wireless Network Communications Link

SCDOT Designation: 677.7

1.1 Description

This work shall consist of installing a Wireless Network Communications Link with all necessary hardware in accordance with the plans and standard drawings to provide a data link between field devices (i.e. Traffic Signal Controllers).

1.2 Materials

Wireless Communications Equipment provided by others (generally SCDOT). Cable shall be as follows or equal:

Superior Essex	Cabling	CAT 5e Ethernet cable
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1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Wireless Network Communications Link.
- The Contractor shall furnish the ENGINEER with any warranties on materials provided by the Manufacturer or Vendor as normal trade practice.
- A Wireless Network Communications Link is used to network two Traffic Signal Cabinets together. Each link consists of Master ODU (Out Door Unit, *Antenna*) connected to a data switch within one of the signal cabinets and a Slave ODU connected to a data switch within the other signal cabinet. Each ODU is aligned to face the opposing ODU. The cable length between the ODU and its associated data switch may not exceed 300 feet.
- Wireless Network Communications Link components at each of the linked traffic signal cabinets includes an ODU, a LPU (Lightning Protection Unit), power supply mounting hardware, and CAT 5e cabling. The ODU is pole mounted per manufacturer's specifications. The LPU and power supply are mounted within the traffic signal cabinet. CAT 5e cable is installed between the ODU and LPU.

1.3.2 Site Survey

- **Perform a radio path Site Survey test before installing any equipment.** For the applicable frequency spectrum of the radios being deployed, perform a spectrum analysis to ensure no competing equipment in the area. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. Typically, if the ODUs can be mounted with clear line of sight between them, this is sufficient to ensure proper operation. If this is not possible, it may be determined that a repeater station is necessary to complete the intended link. Provide the test results to the ENGINEER for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. The ENGINEER will approve final locations of the ODUs and any necessary repeater stations.

1.3.3 Antenna

- Install each ODU in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the NESC) and as specified in the ODU manufacturer's recommendations. Secure the ODU mounting hardware to the pole and route the CAT 5E cable such that no strain is placed on the RJ-45 connectors. Align each antenna/radio to be perpendicular to the ground (using bubble level) and to face the opposing radio

1.3.4 Cable

- Install Cat 5E cable between the ODU and the LPU. Terminate each end with compatible RJ-45 connector. Perform end-to-end continuity test and 1 GigaBit/sec transmission tests using Ethernet Twisted Pair test gear. Provide test results to ENGINEER.
- Lightning Protection Unit (LPU)- Install LPU in Signals cabinet per manufacturer's instructions. Connect CAT 5e cable to LPU

1.4 Measurement

- Pay Item 677048B INSTALL WIRELESS NETWORK COMMUNICATIONS LINK BETWEEN TWO TRAFFIC SIGNALS is measured as EACH unit. This pay item includes furnishing mounting hardware and cable for ODU, installing ODU and cable, installing cabinet equipment, and adjusting ODU as needed for optimum communications for both ends of the link (Master ODU at one signal and Slave ODU at the other signal. Actual ODUs and associated equipment provided by others (generally SCDOT).

1.5 Payment

677048B	INSTALL WIRELESS NETWORK COMMUNICATIONS LINK BETWEEN TWO SIGNALS	EA
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Supplemental Technical Specification for

Detector Loop

SCDOT Designation: 678.1

1.1 Description

This work shall consist of furnishing and installing a Detector Loop within and alongside the roadway, at the locations shown on the Plans, and in accordance with Standard Drawing 678-100-01 Vehicle Detection – Inductive Detection. 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.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Detector Loop.
- The LOCATION and SIZE of each loop shall conform to the Plans and to the Standard Drawings.
- The front of each loop shall typically be located 12 to 36 inches in front of the Stop Line, however, the final location will be determined by the ENGINEER based on field conditions.
- Center loops in the traffic lane in accordance with the Standard Drawings and as shown on the Plans.
- Stage loop installation so that each entire loop installation (from saw cut to sealing) is completed within the same working day with minimum blockage of traffic.
- Cut all presence loops, left turn lanes and side streets, in a quadrupole design, in accordance with the standard drawings.
- Provide a 5-year workmanship warranty for the loops following Final Acceptance. The CONTRACTOR will return to repair or replace any loops rising up or pulling from the pavement or not functioning within warranty period at no additional cost.

1.3.2 Saw Cuts

- Prior to cutting, mark the intended saw cut using paint or chalk on the pavement and obtain approval from the ENGINEER.
- The Contractor shall slot the roadway using a diamond or abrasive rotary power-saw with a blade approximately 3/8 INCH IN WIDTH.
- Use a power-driven walk-along model saw, not a hand-tool.
- The MINIMUM DEPTH of each Saw cut shall be:
 - 2 INCHES DEEP in CONCRETE; and
 - 2-1/2 INCHES DEEP in BITUMINOUS pavement; and
 - 3 INCHES DEEP for any Quadrupole loop or loop with 4 turns.

- Cut the corners diagonally to prevent sharp edges in accordance with the standard drawings. Extend the saw cuts to provide full-depth.
- Wash out and blow dry saw cuts to ensure the cut is free from dust, grit, oil and moisture before the placement of wire. Use compressed air to blow dry.
- If the Engineer gives written approval, the curb and gutter may be saw cut. If saw cutting of curb and gutter is not permitted, drill a 1 ½-inch hole under the curb at a 45 degree angle.
- Avoid pavement seams or cracks. However, when it is necessary to traverse a crack, drill a 2-inch diameter hole at least 3 inches deep, and provide slack in the loop wire to allow for expansion and contraction.

1.3.3 Loop Wire

- Install each loop wire in a continuous and splice-free manner.
- Do not install or provide any wire with cuts, breaks, or nicks in the insulation. The Engineer will not accept damaged loop wire.
- Wire all loops in one direction, counter-clockwise only.
- Each loop shall have the number of turns shown below, or as indicated on the Plans.
 - 6' x 6', 6' x 10' – 4 turns
 - 6' x 15', 6' x 20', 6' x 30', 10' x 20', 10' x 30' – 3 turns
 - 6' x 40', 6' x 50', 10' x 40' – 2 turns
 - Quadrupole loops shall have twice the turns in the middle cut, and be wired in a figure eight pattern, counter-clockwise only
- Form each Detector Loop by installing one continuous length of single conductor (loop) wire in a separate saw cut, from the nearest approved "junction point", around the loop the specified number of turns, then back to the "junction point".
- Place the wire in the cut 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.
- Press the wire to the bottom of the saw cut slot, using a roller or a blunt-stick (similar to a paint stirrer), to seat the loop wire at the bottom of the slot or channel. Do not use a screwdriver or similar sharp tool as this may damage the loop wire insulation.
- After placing the wire in the slot, recheck it for slack, raised portions, and tightness.
- Use 1 INCH LENGTHS of 1/2 inch closed-cell foam-plastic (BACKER-ROD) at 2 foot spacings, to hold the wire at the bottom of the slot. DO NOT use backer-rod around the entire perimeter!
- Form the "pigtail" by twisting together the two ends of the loop wire from the corner of the loop to the "junction point"; Twist the two ends with a pitch of 15 TURNS PER YARD;
- Enclose the loop wire pigtail in conduit from the roadway edge to the "junction point".
- TEST each loop BEFORE SEALING, to ensure inductance is in the range of 50 to 2500 micro-Henrys. Ensure the insulation resistance measured to earth ground is greater than 100 megohms at 500 volts DC. Provide MEGGER TEST and INDUCTANCE TEST before and after sealing, and provide a written record of the test to the ENGINEER on company letterhead.

1.3.4 Lead-In Cable

- Install the lead-in cable in a continuous run, splice-free, and free from cuts or nicks in the insulation.
- At the specified "junction point", splice the twisted "pigtail" from the loop wire to the shielded, (twisted-pair) lead-in cable that runs from the "junction point" to the controller cabinet (terminal).
- Provide an electrically permanent and waterproof seal at the "junction point" splice. Remove 1-1/2 inches of insulation from each wire. Use either a crimped-on or twisted and soldered splice. No wire nuts are allowed. Waterproof seal the entire splice using a method described below:
 - a. Normal Splice – Splice each individual pair (pair of twisted loop wires meeting pair of loop lead-in wires), by using either a crimp-on or a soldered joint. Seal the junctions in a low-voltage, waterproof splice kit. Install the splice kit per the manufacturer's instructions.
 - b. Underwater Splice - Where required on the Plans, install an underwater splice kit according to the manufacturer's instructions.
- The ENGINEER must be present to witness the splicing. Any splices made without the presence of the ENGINEER are unacceptable, and shall be re-spliced.

- Leave sufficient slack in both the lead-in cable and the loop wire, to allow movement of 3 feet from the front of the "junction point". Neatly coil and nylon-tie the slack after completion of the splice.
- In the controller cabinet, label the lead-in cable on an insulated, preprinted-sleeve, slipped over the wire before attachment of a spade-lug connector. Crimp on a spade-lug connector onto each loop lead-in wire.
- In the controller cabinet, do not connect the ground (drain) wire from each lead-in cable; instead, cut it off at the cable sheath, and leave it floating.
- Run the lead-in cable in conduit (in accordance with 675.1 Electrical Conduit) from the "junction point" to the nearest signal pole, or directly to the cabinet if in the same quadrant.
- Run the lead in cable inside a conduit (riser) or metal pole, across span wires, and then down inside a conduit (riser) or metal pole, to the cabinet.
- Install one of the following for the conduit for lead-in cable required to be installed under sidewalks and curbs
 - Rigid Galvanized Steel Conduit
 - SCHEDULE 80 PVC Conduit
 - SCHEDULE 80 HDPE Rolled Conduit
 - Flexible Weather-Tight Steel Conduit

1.3.5 Sealant

- Use QPL approved Loop Sealant in all loops unless specified by the ENGINEER.
- Mix and apply Loop Sealant according to the manufacturer's directions.
- Do not pour Loop Sealant into saw cuts during precipitation of any kind, or at temperatures below 10° C (50° F).
- Completely fill the saw cut and drilled holes with Loop Sealant; do not allow bubbles below the surface; do not over fill the cut, ensuring only a minimum spillover along the joint. Use Duct-Seal to prevent sealant from flowing into conduit ends.
- When the sealant hardens, ensure there is neither a bulge nor depression, but rather a smooth road surface. Ensure the sealant is not over-poured, preventing bulges or bumps higher than the surrounding surface of the roadway. Wipe the area smooth with a squeegee.
- Ensure the sealant has hardened before allowing traffic to move over the area.

1.4 Measurement

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

1.5 Payment

Loop Wire:

6770413	FURNISH & INSTALL NO. 14 COPPER WIRE, 1-CONDUCTOR FOR LOOP WIRE	LF
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Loop Lead-in cable:

See 677.1 Electrical Cable

6770389	FURNISH & INSTALL NO. 14 COPPER WIRE, 4 CONDUCTOR - GRAY	LF
6770394	FURNISH & INSTALL NO. 14 COPPER WIRE, 8 CONDUCTOR - GRAY	LF

Saw Cut:

6780495	SAWCUT FOR LOOP DETECTOR	LF
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Supplemental Technical Specification for

Wireless Vehicle Detection System

SCDOT Designation: 678.2

1.1 Description

This work shall consist of furnishing a Wireless Vehicle Detection System to detect vehicles on a roadway by using battery-powered magnetometer-type SENSORS that communicate their detection data by RADIO RECEIVER &/OR REPEATERS to a CABINET INTERFACE before the data is relayed to a local traffic controller and, optionally, a central software system or a data server, or interface to such, as may be desired.

1.2 Materials

1.2.1 Overview

- The Wireless Battery-Powered Magnetometer Vehicle Detection System shall consist of one or more SENSORS installed in each traffic lane where presence detection is required, avoiding sources of magnetic noise such as underground power cables, overhead high tension power cables, light rail or subway tracks, and power generation stations and sub-stations. The SENSORS shall be located as specified by the intersection plans, with each SENSOR'S supporting CABINET INTERFACE or REPEATER installed as necessary to provide communications. Each SENSOR in an installation shall be capable of being individually configured with its own sensitivity level. A single SENSOR shall be capable of being configured with a sensitivity level that approximates the detection zone of a standard 6' x 6' inductive loop. Each SENSOR shall be capable of being configured with relatively higher or lower sensitivity levels as may be required to detect bicycles, motorcycles, or light rail. As an option as directed by the plans, up to two SENSORS properly configured shall be capable of detecting motorcycles in a standard traffic lane and bicycles in a designated bicycle lane. A CABINET INTERFACE shall support the relay of SENSOR detection data through several interfaces as required by the application.
- Communications between a SENSOR and RADIO RECEIVER can be direct, via a single REPEATER, or via two REPEATERS operating in tandem. Communications between the SENSORS and the RADIO RECEIVER or REPEATER and between the REPEATER and RADIO RECIEVER or another REPEATER shall be via radio. Detection data shall be relayed from each CABINET INTERFACE to a local traffic controller for real- time vehicle presence detection using contact closure signals or serial communication interface.
- As an option, data shall be capable of being relayed from each CABINET INTERFACE to a central software system or central server over standard IP (Internet Protocol) networks. An option to provide data via a web page interface may be required.

1.2.2 Radio Link

The radio links between each SENSOR and RADIO RECEIVER or REPEATER and between each REPEATER and RADIO RECEIVER or each REPEATER and REPEATER shall conform to the following requirements.

- The physical layer of the radio links (i.e., the over-the-air data rate(s), modulation type(s), forward error correction, bit interleaving, channel coding, and other aspects of the transmitted signal) shall conform to published standards (e.g., IEEE, ITU-T, etc.).
 - The center frequencies, bandwidths, and transmit power levels of the radio links shall allow operation in an unlicensed frequency band.
 - Frequency channels shall be employed by the SENSORS, CABINET INTERFACE, and REPEATERS to avoid interference with other devices operating in the unlicensed band.
 - Either user-configurable frequency assignments or frequency hopping technology shall be provided. If frequency channels are user-configurable, at least 16 frequency channels shall be supported. If spread-spectrum/frequency hopping technology is provided ensure technology can address potentially interfering radio transmissions in the unlicensed band.
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- The link budget (i.e., transmit power plus transmit antenna gain plus receive antenna gain minus receive sensitivity, where receive sensitivity shall assume a 1% packet error rate) for all radio links shall be 93 dB or greater.

1.2.3 Components

The Wireless Vehicle Detection System shall consist of one or more of the following:

- **SENSORS** - installed in-pavement in each traffic lane.
- **RADIO RECEIVER** - mounted on the side of the roadway.
- **CABINET INTERFACE**- CABINET INTERFACE located in traffic signal cabinet will provide SENSOR information processing and support the interface between a RADIO RECEIVER and a standard traffic controller using contact closure signals or standard serial communication interface such as NEMA TS2 Port 1.
- **EXTENSION MODULE** - to provide additional detector outputs to a traffic controller.
- **REPEATER/ANTENNAS** - Wireless REPEATERS/ANTENNAS mounted on the side of the roadway, either at the intersection or adjacent to set back sensors, serving to extend the radio range of a RADIO RECEIVER.
- EPOXY, CAT5 / ETHERNET CABLE, ELECTRIC CABLE , SOFTWARE (Incidentals)

1.2.4 Sensor

- Each SENSOR shall detect a vehicle by measuring changes in the earth's magnetic field near the SENSOR as caused by a stopped or passing vehicle (i.e., magnetometer-type detection). The SENSOR shall sample the earth's magnetic field at a rate of 128 Hz. The SENSOR shall communicate time-stamped ON and OFF vehicle detection events. Each SENSOR shall automatically recalibrate in the event of a detector lock. Each SENSOR shall communicate by radio to a nearby RADIO RECEIVER or REPEATER RADIO. Each SENSOR shall transmit its detection data within 150 ms of a detected event. Each SENSOR shall automatically re-transmit a detected event if no acknowledgement is received from the access point. Each SENSOR may stop retransmission after 8 attempts. Each SENSOR shall transmit a unique identifying code. Each SENSOR shall respond within 100 seconds when the access point is powered on and transmitting. When no RADIO RECEIVER or REPEATER is present or powered on and transmitting, the SENSORS are not required to detect vehicles.
- All SENSOR components shall be contained within a single housing. The SENSOR housing shall conform to NEMA Type 6P and IEC IP68 standard. The SENSOR components shall be fully encapsulated within the housing to prevent moisture from degrading the components. The SENSOR housing shall be capable of being installed in a 4 to 4.5 inch diameter hole with a minimum 2.25 inches. A SENSOR shall operate at temperatures from -37 F /-38.3°C to +176 F / +80°C. A SENSOR shall be battery-powered with an average lifetime of ten (10) years when the SENSOR is configured for and operating under normal traffic conditions.

1.2.5 Radio Receiver (At Intersection)

- A RADIO RECEIVER shall support at least 48 SENSORS with a 0.125 second latency. A RADIO RECEIVER shall meet the temperature and humidity requirements of section 2.1.5 of NEMA Standard TS2-2003. All RADIO RECEIVER components (not including antennas) shall be contained within a single housing. The RADIO RECEIVER housing shall conform to NEMA Type 4X and IEC IP67 standards. A RADIO RECEIVER shall be no larger than 12"H x 8"W x 7"D.
- The RADIO RECEIVER shall communicate to the CABINET INTERFACE utilizing a standard CAT5e or higher Ethernet cable. The RADIO RECEIVER shall have a weatherproof Ethernet connector on the bottom. The Ethernet connector shall be shipped with a cover firmly attached to provide protection from the elements prior to cable connection. The weatherproof connector shall not require any specialized tools for installation.
- A means shall be provided for surge suppression and isolation between the radio receiver and the cabinet interface for a wired connection. Electrical isolation of 1000V or greater and transient / surge protection shall be provided for the interface between the Cabinet Interface and Radio Receiver. This may be provided integral to the devices or as a separate unit, or combination thereof.

1.2.6 Cabinet Interface

- Detection data shall be communicated to a standard roadside traffic controller via a CABINET INTERFACE capable of being installed in a standard 170 cabinet. Type 170, Type 2070 and ATC controller types shall be supported. As an option, detection data shall be communicated over TCP/IP via an integrated 10Base-T Ethernet interface or a NEMA TS2-2003 Port 1 serial interface. The CABINET INTERFACE shall be capable of simultaneously communicating detection data via the contact closure interface and other interfaces.
- Each CABINET INTERFACE shall be capable of communicating with at least 2 RADIO RECEIVERS. EXTENSION MODULES shall provide additional contact closures (user configurable from 1 to 4 outputs each). The CABINET INTERFACE shall provide all the higher level processing and interface functions of the system. Each CABINET INTERFACE shall provide detector data as contact closure signals to the traffic controller or via a serial communications interface. A CABINET INTERFACE shall connect to standard 170/2070 input files or NEMA detector racks. One or more EXTENSION MODULES shall provide up to 64 channels of detection data from a single CABINET INTERFACE's supported SENSORS, where each channel comprises an optically isolated contact closure relay and, if configured for TS2 operation, an additional output meeting TS2 requirements, to indicate the channel status. Each CABINET INTERFACE and EXTENSION MODULE shall be configurable. A CCI card shall provide contact closure signals in either presence or pulse mode. A CCI card shall provide up to 31 seconds of delay timing. A CCI card shall provide up to 7.5 seconds of extension (carryover) timing. The CCI and EXTENSION MODULE front panel shall provide status LEDs to monitor Detection channel status, and Faults. The CCI and EXTENSION MODULE front panel shall be either software or via front panel switches configurable to provide Presence or pulse mode, Delay timing and Extension timing.
- A CABINET INTERFACE or EXTENSION MODULE shall be powered by the input file/detector rack backplane via an 11- 26 VDC input. Power Consumption for a CABINET INTERFACE (without optional cellular interfaces) shall be under 5 watts. An EXTENSION MODULE shall be surge protected to GR-1089 standards. A CABINET INTERFACE and EXTENSION MODULE shall meet the requirements of NEMA TS2-2003, section 2.1.5 Temperature and Humidity, and section 2.1.7 Transients, Input-Output Terminals.

1.2.7 Extention Module

- An EXTENSION MODULE shall be available to allow additional detector outputs to be interfaced to the traffic controller. When interfacing through the detector card rack, the extension module shall allow up to four detector outputs to be interfaced to detector card slot(s).

1.2.8 Repeater/Antenna

- A REPEATER/ANTENNA radio communicating directly to a CABINET INTERFACE shall support at least 10 SENSORS. A REPEATER/ANTENNA communicating to a CABINET INTERFACE via an intermediate REPEATER (i.e., tandem operation) shall support at least 6 SENSORS. A REPEATER/ANTENNA shall be battery-powered, solar powered or a combination of the two. The REPEATER/ANTENNA battery shall be long-term (5+ years) and field replaceable. A

REPEATER/ANTENNA shall meet the requirements of NEMA TS2-2003, section 2.1.5 Temperature and Humidity. All REPEATER/ANTENNA components shall be contained within a single housing.

1.2.9 Epoxy

- The epoxy shall be a two part poly-urea based joint sealant. It shall have self-leveling characteristics. The surface the epoxy will be bonding to shall be free of debris, moisture and anything else which might interfere with the bonding process. The epoxy shall be approved by the manufacturer of the detection system. Epoxy is an incidental item to be included in installation of SENSORS.

1.2.10 Software

- Each SENSOR, access point contact closure, RADIO RECEIVER and REPEATER/ANTENNA shall be capable of accepting software and firmware upgrades. The Wireless Battery-Powered Magnetometer Vehicle Detection System shall provide software operating on conventional notebook/portable PCs or utilize a standard web browser program to support configuration of a SENSOR, to support configuration of an access point, to support configuration of a REPEATER, to store and retrieve detection data.

1.2.11 Certification

- The Contractor SHALL FURNISH, the design details and drawings prior to installation in sufficient detail for complete evaluation and comparison with these Specifications.

1.2.12 Warranty

- Performance shall be warranted for a period of **60 months** of the date of purchase and shall include repair or replacement of any component of the Wireless Vehicle Detection System. Failure due to workmanship, materials, and manufacturing defects shall be warranted for repair or replacement of the first 60 months of the date of purchase. The vendor shall replace any failed components within 30 calendar days of notification.
- During the warranty period, technical support shall be available from the supplier via telephone within 2 business days of the time a call is made by a user, where this support shall be provided by factory-authorized personnel or factory-authorized installers.
- During the warranty period, standard updates to the software shall be available from the supplier without charge.

1.3 Construction

- Install wireless detection system in accordance with manufacturer’s instructions.
- Install wireless detectors using coring and fill hole with epoxy to obtain flush mounted installation
- Install overhead receivers/ repeaters to ensure proper communications with detectors
- Coordinate with manufacturer or their representative to ensure proper system installation

1.4 Measurement

Pay Item 677049C, 677049D, 677049E, and 677049F includes furnishing and installing all necessary hardware, software, mounting hardware, equipment, cables, and components required to obtain detection zones complying with this specification and as shown on the plans or listed in the special provisions. Such payment shall be full compensation for installing all equipment, labor, and incidentals necessary to complete the work as specified. The other pay items listed below are specifically for furnishing and installing that item, and include any necessary mounting hardware, cable and other incidental items necessary for installation of that item.

1.5 Payment

677049C	FURNISH WIRELESS DETECTION SYSTEM W/O SENSORS (INC SETBACK DETECTION CAPABILITY FOR 2 DIRECTIONS	EA
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677049D	FURNISH WIRELESS DETECTION SYSTEM W/O SENSORS (INC SETBACK DETECTION CAPABILITY FOR 3 DIRECTIONS	EA
677049E	FURNISH WIRELESS DETECTION SYSTEM W/O SENSORS (INC SETBACK DETECTION CAPABILITY FOR 4 DIRECTIONS	EA
677049F	FURNISH WIRELESS DETECTION SYSTEM W/O SENSORS (w/o SETBACK DETECTION CAPABILITY)	EA
677049G	FURNISH MANUFACTURER TECHNICIAN ASSISTANCE	HR
6770494	FURNISH & INSTALL FLUSH MOUNTED WIRELESS SENSOR INC EPOXY	EA
6887961	INSTALL FLUSH MOUNTED WIRELESS SENSOR	EA
6887962	REMOVE FLUSH MOUNTED WIRELESS SENSOR	EA
6887963	INSTALL SET BACK LOOP EQUIPMENT	EA
6887964	INSTALL CABINET EQUIPMENT	EA

Supplemental Technical Specification for

Electric Service

SCDOT Designation: 680.1

1.1 Description

This work shall consist of furnishing and installing an Electric Service to provide electric power to traffic signals, at locations shown on the Plans, and in accordance with the Standard Drawings and Power Company procedures.

1.2 Materials

- All materials shall be NEC compliant.
- Meter, Meter Box (Pan type), Hub Access.
- Power Connection – Single-phase, 120/240 Volt, 3-Wire, 60-Hertz alternating current supply.
- Cable - 3-Wire (W, BL, RD), THHN/THWN, No.6 AWG
- Disconnect Switch - NEMA Standard Type 3R, weatherproof, Circuit Breaker Type, with a tab for pad-locking the cover closed, 3-Wire Design (2-circuit), with solid neutral. The panel shall be completely enclosed; there shall be no gaps in the panel with the door shut.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Electric Service.
- Perform all work in accordance with the Plans, the Standard Drawings and the REQUIREMENTS OF THE LOCAL POWER COMPANY. All work shall be in accordance with the National Electric Code (NEC), and applicable local Codes.
- Coordinate with the ENGINEER and the Power Company Representative as necessary to arrange the schedule for power connection.
- The Engineer will provide contact information for the Power Company.
- Make all necessary arrangements with the Power Company to insure having the needed power available at the TIME OF SIGNAL TURN-ON. Immediately report any difficulties in securing the service of the Power Company to the Engineer.
- Coordinate with the Engineer and the Power Company to determine the exact location of the electric service. The Electric Service is generally located as indicated below:
 - a) Overhead service drop to controller pole;
 - b) Overhead service drop to service pole, then underground to controller cabinet (isolated);
 - c) Underground Power Company feed, to service on the back of controller cabinet.
- The CONTRACTOR shall obtain all ELECTRIC PERMITS required; and shall arrange for INSPECTION at completion.
- Use 1-inch diameter SCHEDULE 80 PVC Conduit and Fittings or Rigid Metallic Conduit for the Electric Service; install it to extend from the point of Power Company attachment, through the meter and disconnect assembly, to the controller cabinet, in accordance with 675.1 ELECTRICAL CONDUIT.
- Install a weather head to the above conduit for overhead service connections. Install a strain Clevis, to create a 1 feet minimum drip loop.
- Use rustproof hardware; use stainless steel or galvanized steel parts; use STAINLESS STEEL BANDS for attachment to steel poles.

- Space the bands a maximum of 3 feet and at the top and bottom of the pole.
- When specifically required by the Utility Company or on wood poles, substitute Conduit Clamps/strap, fastened with galvanized screws, for the bands

1.3.2 Meter

- Provide a Meter for the electric service, unless otherwise directed by the Engineer. Provide the necessary hardware accordingly.
- The CONTRACTOR shall furnish and install the METER BOX (PAN), and the HUB.
- Provide power connection that is a SINGLE-PHASE, 120/240 VOLT, 3-WIRE, 60-Hertz alternating current supply.

1.3.3 Disconnect Switch

- Provide disconnect switch that is 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 and until SCDOT installs a padlock.

1.3.4 Electric Service

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

<u>ITEM</u>		<u>USAGE</u>	
		<i>Flashing Beacons</i>	<i>Traffic Signal</i>
Disconnect Breaker			
	Box Rating (for uniformity):	60 AMP	60 AMP
	Circuit Breaker (one side):	20 AMP	50 AMP
Cable			
	3-Wire (W, BL, RD), THHN/THWN	No.6 AWG	No.6 AWG
Conduit			
	Schedule 80 PVC (Wood Poles)	1 inch	1 inch
	Rigid metallic (galvanized or aluminum) for steel or concrete poles	1 inch	1 inch

- Install Electrical Service Cable (Type THHN/THWN, sized per above table, 3-WIRE, (White, Black, red) 600 Volt, Copper only, stranded, with cable lugs) from the point of Power Company attachment to the Meter. From the meter to the cabinet install white, (black or red) and green. Install Electrical Service Cable in separate conduit from all other Electric Cable that connects to signal heads, pedestrian head or detection. At no place shall the service cable be in the same conduit as signal cables or loop lead-ins.

1.3.5 Ground System

- Ensure the resistivity of the electrical system EARTH GROUND shall be 15 OHMS OR LESS, as measured with an appropriate instrument which was calibrated not more than 60 days prior to the date of performing such tests.

- Ensure the poles, ground rods, ground wires, span wires, etc. forming the traffic signal, form a "GROUNDING ELECTRODE SYSTEM" as defined by Article 250 of the NATIONAL ELECTRIC CODE.
- Provide a 16 mm by 5/8 inch by 8 feet (minimum) ground rod, copper-clad, with brass or bronze ground rod clamp. EXOTHERMICALLY WELD the service ground rod; Connect all other ground rods with clamps.
- Provide grounding wire for the service that is No. 6 AWG, Bare, solid or stranded copper wire Exothermically Welded. (Note that this is in addition to the solid grounding wire running down each wooden pole.)

1.4 Measurement

- Complete Electrical Service 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.

1.5 Payment

6800499	FURNISH & INSTALL ELECTRICAL SERVICE FOR TRAFFIC SIGNAL	EA
6800500	MODIFY EXISTING ELECTRICAL SERVICE FOR TRAFFIC SIGNAL	EA

Supplemental Technical Specification for

Splice Box / Junction Box

SCDOT Designation: 680.2

1.1 Description

This work shall consist of furnishing and installing a Splice Box or Junction Box at the locations shown on the Plans in accordance with these specifications and Standard Drawing 675-100-01 Splice Box – Installation Details.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Electrical Conduit.
- Provide a Splice Box including a Box and Cover, installed over aggregate, in accordance with the Standard Drawings.
- Install the Splice Box for use as a signal cable electrical enclosure.
- Install the Junction Box, where indicated on plans, for use as a loop detector “junction point”. Unless shown mounted on a pole, install the junction box in the dirt, at the depth of the conduit run, and covered with earth.

1.3.2 Splice Box

- Construct the Splice Box in accordance with the Standard Drawings, at locations shown on the Plans.
- Construct the Splice Box such that when the Box and Cover are in place, they are flush with the adjacent pavement, ground, or sidewalk, as shown in the Standard Drawings.
- Place patching Concrete around any Box installed in pavement.
- Place boxes at least 1 foot behind the curb-line or edge of roadway or as shown on the plans.

1.3.3 Placed Before Pouring.

- Where shown on the Plans, place Custom Splice Boxes in roadways or structures, prior to pouring the concrete. Typical usage would be in a bridge deck. Firmly attach the incoming conduit to the bottom reinforcement bar mat, or to the bottom wire-mat, using plastic tie-wraps every 2 feet. CAUTION: COMPLETELY PLUGG/BLOCK/SEAL THE BOTTOM OF THE SPLICE BOX AND THE CONDUIT ENDS TO PREVENT CONCRETE PENETRATION. When used on a bridge, install the Splice Boxes near the center line, and terminate the conduit in Splice Boxes at each end.

1.3.4 Conduit

- Install conduit (in accordance with 675.1 ELECTRICAL CONDUIT) to enter the Box at the bottom and to extend at least 2 inches beyond the inside wall.
- Install conduit to enter from the direction of the run unless otherwise permitted by the ENGINEER.
- Ensure all metallic conduit ends within the Box have grounding bushings with plastic inserts; and ensure they are bonded using #6 AWG bare copper ground wire. Provide end bushings to prevent chaffing in plastic conduits.

- After placing the electrical cable, pack the completed conduit ends with "duct-seal" or other equivalent material to prevent water from entering the conduit. Insert steel wool at conduit ends to prevent rodent/pest intrusion. Cap spare conduit.

1.4 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.

1.5 Payment

6800518	FURNISH & INSTALL 13"X24"X18"D.ELEC.FLUSH UNDGRD.ENCLOSURE-(STR.POLY.CONC.) HD	EA
680052C	FURNISH & INSTALL 17"X30"X24"D.ELEC.FLUSH UNDGRD.ENCLOSURE-(STR.POLY.CONC.) HD	EA
6800508	FURNISH & INSTALL 12"X12"X12"D.ELEC.FLUSH UNDGRD.ENCLOSURE-(STR.POLY.CONC.) HD	EA
6888100	INSTALL ELECTRICAL FLUSH UNDERGROUND ENCLOSURE	EA

Supplemental Technical Specification for

Wood Pole / Back Guy Assembly

SCDOT Designation: 682.1

1.1 Description

This work shall consist of furnishing and installing CCA treated Wood Poles and Back-Guy cable assemblies, 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 and in accordance with the Standard Drawing 682-300-01 Steel Cable – Wood Pole and Span Wire Service Grounding and Bonding. Each wood pole installation shall include all related overhead and underground hardware, and back guy assemblies as provided elsewhere.

1.2 Materials

Furnish a wood pole meeting the following requirements:

- 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 or spikes
 - Excessive knots
 - Scars deeper than 1 inch or longer than 3 feet
 - Excessive butt-swell
 - More than one twist per pole length
 - Sweep in two planes
- 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 5 feet of length exceeds 1.5 inches at any location, as determined by a straight edge.
- 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 3 inches, or 90 percent of the sap-wood. The retention shall be at least 0.60 POUNDS PER CUBIC FOOT, as determined by AWPA Standards.
- Provide Class II pole in the length specified in pay item.

- Each pole shall have a "brand" 12 feet above the butt-end, showing the Manufacturer, Plant-location with month and year of treatment, "Southern Pine CCA", 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.
- Each pole shall have the "Brand Mark" of an inspection-company that has been approved by the Department.

Furnish Back-Guy Assembly as follows:

- From the top-down, a Back-Guy Assembly shall consist of: eye-type thru-bolt, guy-hook, strandvice (or 3-bolt clamp), jumper-bonding clamp, the steel cable (3/8-inch guy-cable stranded), another strandvice (or 3-bolt clamp), and a Screw-type guy anchor.
- 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 to ensure rust proof.
- Acceptable parts are:
 - a) Guy Anchors - One piece screw type guy-anchors, shall conform to EEI-TD-2, 1 inch diameter, 8- FEET LONG, thimble eye type. (Joslyn No. J-6550-WCA or approved equal)
 - b) Guy Guards shall conform to REA Item "AT" yellow plastic (PVC) sunlight resistant, 8 feet long.
 - c) Spool Insulators shall conform to REA Item "CM".
 - d) Insulators shall conform to REA Item "W".
 - e) Machine Bolts shall conform to REA Item "C".
 - f) `J' hooks - Reliable No. 5552 (or approved equal).
 - g) Guy and Messenger Cable Dead Ends - Reliable Universal Strandvice (or approved equal)
 - h) Thimbleye Bolts shall conform to EEI-TD-4.
 - i) Thimble Nuts shall conform to EEI-TDJ-5.
 - j) Washers shall conform to EEI-TDJ-10.
 - k) Angle Thimbleye shall conform to REA Item 5.
 - l) Cable- 3/8 INCH DIAMETER CABLE (682.3 STEEL CABLE)
 - m) Cable Clamps: 3-bolt clamps shall conform to EEI-TDJ-23, (4 inch and 6 inch sizes)
 - n) Clevises shall conform to EEI-TD-20.
 - o) Side-walk Bridge-over shall be a stress supporting spreader-type, bolting to the wood pole.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Wood Poles and/or Back-Guy Assemblies.

1.3.2 Utility Poles

- Install poles used for joint-use UTILITIES, in accordance with all local codes, and with the requirements of the Utility Company. Provide Cross Arms if required by the Utility Company.

1.3.3 Location

- Install the pole in the general location shown on the Plans.
- Coordinate with the Engineer to stake the field location of the pole, considering the property lines, underground utilities, and overhead clearances (including the guy anchor assembly).
- Engineer will approve staked locations, however contractor is responsible for locating utilities.
- If utility conflicts are discovered, relocate pole in coordination with the Engineer's approval.
- The pole location may have to be moved based on unmarked utilities.

1.3.4 Hole

- Drill a 6-foot DEEP hole, unless indicated otherwise in standard drawings.
- The diameter of the hole shall be larger than the pole by approximately 4 inches all around.
- Ensure the hole is a uniform diameter, and cleanly augured.

1.3.5 Installation

- Install poles to be vertical; if poles are corner signal poles, RAKE the pole away from the strain, 2 to 4 inches per 10 feet length.
- Install back guy assembly in line with the strain of each span wire.
- After installing, back-fill the hole with clean earth or sand (no rocks or debris), placed in 1 foot layers; moisten and compact each layer.
- Remove excess earth from the site; A 2-inch mound around the pole base is acceptable.

1.3.6 Sidewalk

- When installing the pole in a sidewalk, cleanly cut out the sidewalk 6 inches larger than the pole on all sides.
- Install conduit runs in the cut.
- Install as indicated in 1.3.5 Installation, leaving 4 inches for concrete placement.
- Install expansion joint material around the pole and tack in place, after installation of the pole and back filling the hole.
- Pour concrete around the pole to a depth of 4 inches; neatly troweled level. This work is incidental to pole installation.

1.3.7 Grounding

- Ground each pole in accordance with the Standard Drawings.
- Install a No. 6 AWG, SOLID, bare-copper ground wire (ASTM B2) to run the entire length of wooden poles, and extend 6 inches above the top end.
- Securely attach and bond the ground wire to the pole while it is lying on the ground.
- Ensure the ground wire extends 6 inches above the top end with a 2-foot coil (slack) at the top end, and extends down to the bottom with another 2-foot coil on the bottom end.
- Attach the ground wire (and the coils) using galvanized 1-1/2 inch wire staples, on (2 foot) centers above 14 feet, and on 1 foot centers below 14 feet. (The spacing change will be at 8 feet above grade.)
- Provide Ground Rods that are copper-clad, conforming to EEI-TDJ-30, having a minimum size of 5/8 inch by 8 feet in length.
- Use a ground rod clamp that is heavy-duty bronze or brass.
- Provide a GROUND ROD on one wood pole at each intersection, typically on the pole having the electrical service from the Power Company.
- Drive the ground rod vertically into the earth, until it extends about 2 inches above local grade.
- Use a separate No. 6 AWG bare, STRANDED/SOLID copper wire to bond the electrical service and the overhead cable (and pole ground wire) system to the ground rod, using a grounding clamp.

1.3.8 Back- Guy Assembly

- Back Guy each wood pole used to support signal span wires.
- Install Back-Guy Assemblies on wood poles used to support messenger cables especially at turns, and as directed by the ENGINEER.
- Install sufficient numbers of back-guy assemblies to ensure the stability of wood pole installations. This may include:
 - Double-guying
 - Extra-large anchors
 - Re-guying Utility Company poles.
- Install a Back-Guy Assembly:
 - a) Where shown on the plans;
 - b) In conjunction with installation of Steel Cable as span wire;
 - c) In conjunction with the installation of a wooden pole;
 - d) Where required by the Utility Company to "dress" pole to which signal equipment is attached; or,
 - e) At corner/turning wood poles that are used for messenger cable runs.

- A separate pay item is provided for Back Guy installation
- Inform the ENGINEER when additional back guy assemblies are required.
- Ensure 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).
- Stage the installation of the wood pole, Back-Guy Assembly, and the span wire, for the safety of the motorist, pedestrian, and signal construction worker.
- Stretch, adjust, and then RE-ADJUST the span wire and Back-Guy Assembly to produce the specified amount of span wire sag, the proper signal head road-clearance, and still create a nearly vertical wood pole.
- Ensure the Back-Guy Assembly is sufficiently strong to handle the pull of all span wires, considering the earth/soil type into which the ground anchor is buried. Provide EXTRA LARGE ANCHORS and/or MULTIPLE-ANCHOR ASSEMBLIES if needed. Use special anchors for solid rock.
- Where a pedestrian sidewalk is adjacent to a wood pole, furnish a sidewalk "bridge-over" assembly.
- Ensure the compass angle of the Back-Guy is reasonably IN LINE with the strain of the overhead cable: that is, in line with each span wire. For corner signal wood poles, install two (2) Back-Guys, installed at right angles to each other. Using a single diagonal Back-Guy is generally unacceptable, unless approved by the ENGINEER.
- Install the Back-Guy (wherever possible) to provide as a minimum: rise=2 / run=1 (i.e. 2/1). For example, if the Back-Guy is attached at 26 feet, the anchor should be at a minimum of 13 feet from the pole. This corresponds to an angle with the earth of about 60 degrees.
- Perform all work within the public Right of Way, and take particular to assure that the Back-Guy does not extend into private property.
- Install the Back-Guy where it will not interfere with traffic, giving particular attention to private driveways. Where damage is likely (e.g. edge of driveway) install a STEEL GUY GUARD to protect the cable. When shown on the Plans, place a CONCRETE TIRE/WHEEL STOP (curb) at the base of the Back-Guy, anchored/pinned with 2 feet pieces of reinforcement bar.
- Do not splice the steel cable used in the Back-Guy assembly.

1.3.9 Inspection

- The ENGINEER will 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.

1.3.10 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.
- Contractor shall replace any poles NOT meeting this inspection, without further cost to the project.

1.4 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.
- 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.

1.5 Payment

Wood Pole

6825020	FURNISH & INSTALL 35' WOOD POLE - CLASS II - CCA TREATED(0.60)	EA
6825021	FURNISH & INSTALL 40' WOOD POLE - CLASS II - CCA TREATED(0.60)	EA
6825023	FURNISH & INSTALL 50' WOOD POLE - CLASS II - CCA TREATED(0.60)	EA
6825025	FURNISH & INSTALL 60' WOOD POLE - CLASS II - CCA TREATED(0.60)	EA

Back-Guy Assembly

6825045	FURNISH & INSTALL 3/8" BACK GUY FOR WOOD POLE	EA
6825046	FURNISH & INSTALL 3/8" SIDEWALK GUY	EA
6825047	FURNISH & INSTALL 3/8" AERIAL GUY	EA

Supplemental Technical Specification for

Steel Cable

SCDOT Designation: 682.3

1.1 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 at locations shown on the Plans and in accordance with the Standard Drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Steel Cable.

1.3.2 Span Wire

- Install all Span Wire as shown on the plans and in accordance with the Standard Drawings. Note that different methods and materials are required for Wood Poles and Steel Poles.
- Before erecting the Span Wire, the Contractor shall determine the length of cable required to span the distance indicated on the Plans. Allow sufficient additional length to compensate for sag, pole connections, and adjustments, to make the whole assembly consistent with the plans and the Standard Drawings. NO MID-SPAN SPLICES SHALL BE PERMITTED.
- Set the Span Wire so that the height of the installed signal heads, including all hardware, shall conform to the clearances shown on the Standard Drawings.
- Do not permanently "tied-off" the Span Wire until all signal heads, signs, and cables are in place.
- Do not erect any Span Wire which lays on, or is likely to rub a Utility Company's cable. Protect any Span Wire erected within 6 inches of any other cable, wire, or structure with plastic wire-guards.
- When required by the Utility Company, or by the applicable electrical Code, install strain-type fiberglass insulators.
- **Cables from STEEL POLES**
 - a) Steel Poles are essentially electrical conductors.
 - b) Use a Roller Type Pole Clamp attached at the proper height.
 - c) Secure the free-end of the cable with a 6 inch galvanized steel clamp, with 5/8 inch galvanized bolts. Place the clamp approximately 1 foot from the pole. Cable-grips are not permitted.
 - d) Cover the ends of the cable with "servisleaves" to prevent unraveling.
 - e) The SAG shall be 3%, TO 5%, fully loaded.
- **Cables from WOODEN POLES**
 - a) Wooden poles are essentially electrical insulators, and thus require extensive GROUNDING and BONDING procedures, in accordance with the Standard Drawings.
 - b) The SAG shall be typically 5%, fully loaded.
 - c) The height of attachment shall be sufficient to provide the required road-clearance, including sag.
 - d) Shall be installed in accordance with the requirements of the Utility Company.
 - e) May require the installation of a back guy assembly as required in 682.1 WOOD POLE/BACK GUY ASSEMBLY.

f) Shall be electrically bonded.

1.3.3 Messenger Wire

- Where Messenger Wire is attached to traffic signal poles, install it in the same manner as specified for span wire, but with relatively little sag.
- Where Messenger Wire is attached to utility poles, install it in accordance with the UTILITY COMPANY'S SPECIFICATIONS.

1.3.4 Tether Wire

- Where Steel Cable is specified to tether signal heads and/or traffic signs, install it in accordance with the Standard Drawings. Galvanized S-hooks should be used at the pole ends to permit "break-away" action.

1.3.5 Cable Supports

- Use Cable Supports to support electrical cables from span wire and messenger wire. Place Cable Supports at 10 INCH INTERVALS.
- When Aluminum Tie-Wraps are used, install 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.

1.4 Measurement

- Measure Steel Cable of the SIZE specified by the LINEAR FEET of material as actually placed, which shall include cable supports, clamps, insulators, and all other miscellaneous hardware and fittings. (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.

1.5 Payment

6825092	FURNISH AND INSTALL 3/8" GALVANIZED STEEL CABLE (Span Wire)	LF
6825090	FURNISH AND INSTALL 1/4" GALVANIZED STEEL CABLE (Messenger Wire)	LF

Supplemental Technical Specification for

Pedestrian Pole and Base

SCDOT Designation: 682.4

1.1 Description

This work shall consist of furnishing and installing a Pedestrian Pedestal Pole and Base in accordance with these Specifications and the Standard Drawing 686-300-01 Pedestrian Treatments – Pedestrian Head/Button Mounting Types and Foundations.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Pedestrian Pole and Base.
- Install Pedestrian Pedestal Poles where shown on the Plans and as needed to accommodate pedestrian movements.
- Mount Pedestrian Pedestal Poles so that no portion of the assembly (including the pedestrian head) is closer than 24" inches to the face of the curb.
- Powder-coating may be required if pay item is provided or if specified in the special provisions or on the signal plans. Perform the powder-coating over the aluminum poles at the factory or during the manufacturing process.

1.3.2 Installation

- Construct the foundation to the dimensions shown on Standard Drawings.
- Cap two 1- inch conduit elbows at both ends and secured in place in the excavation before pouring any concrete. The size and number of elbows shall be that necessary to mate with the incoming runs.
- Ensure all conduit elbows shall extend beyond the side of the finished foundation by approximately twelve inches, in the direction of, and at a depth matching the incoming conduit.
- Set 4 Anchor Bolts using pre-formed templates (wood or metal), to provide a "bolt-circle" in accordance with the Dimension Chart, or with recommendations of the base manufacturer. Leave the templates in place for two days (48 hours) or until the forms are removed.
- Mix, place and test concrete in accordance with applicable portions of SCDOT STANDARD SPECIFICATIONS Sections 701, 702, 703, and 704.
- Fasten the pedestrian pole base to the concrete foundation using appropriate hardware.
- Erect and tightly screw the aluminum pole into the base.
- Tighten the setscrew to prevent counter rotation of the aluminum pole.

1.4 Measurement

- Furnishing and installing pay items include pedestrian pedestal pole, base, and foundation installation by EACH including all required incidental hardware and work to install.

1.5 Payment

6825480	FURNISH & INSTALL 4' BREAK-AWAY ALUMINUM PEDESTAL POLE AND BASE	EA
6825482	FURNISH & INSTALL 8' BREAK-AWAY ALUMINUM PEDESTAL POLE AND BASE	EA
6825484	FURNISH AND INSTALL 10' BREAK-AWAY ALUMINUM PEDESTAL POLE AND BASE	EA

Powder-coating Option:

6888192	POWDERCOATING OPTION FOR 4' ALUMINUM PEDESTAL POLE	EA
6888193	POWDERCOATING OPTION FOR 8' ALUMINUM PEDESTAL POLE	EA
6888194	POWDERCOATING OPTION FOR 10' ALUMINUM PEDESTAL POLE	EA

Foundation Only:

Only for use where pedestrian pole and base is provided by others.

6825486	INSTALL CONCRETE FOUNDATION FOR ALUMINUM PEDESTAL POLE	EA
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Supplemental Technical Specification for

Battery Backup System

SCDOT Designation: 684.1

1.1 Description

This work shall consist of installing and/or furnishing Battery Back-Up Systems for installation at traffic signals in accordance with these Specifications, at the locations shown on the Plans, and in accordance with manufacturers specification and Standard Drawings. This item shall include all electrical accessories and other items specified.

1.2 Materials

Acceptable materials shall meet Material Specification M684.1 Battery Back-up System, http://www.scdot.org/doing/technicalPDFs/publicationsManuals/trafficEngineering/TrafficSignal_MaterialSpecs.pdf.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Battery Back-Up System.
- The Contractor shall furnish the Engineer with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice or the match warranty on existing state contract items.

1.3.2 Cabinet/ Foundation

Install cabinet enclosure in accordance with manufacturers specifications and instructions, including any foundation or mounting assemblies.

1.3.3 Battery Back-up System

Install Battery Back-Up System in accordance with manufacturers' specifications and instructions, to operate traffic signal during power outages or at specified times. Contractor shall test Battery Back-up System for SCDOT approval prior to payment.

1.4 Measurement

- Battery Back-up System will be measured by EACH including all equipment, cables, conduit, cabinet enclosures and foundations/mounting elements, and batteries.

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1.5 Payment

6845518	FURNISH & INSTALL BATTERY BACK-UP SYSTEM, INCLUDING FOUNDATION	EA
6888243	INSTALL BATTERY BACK-UP SYSTEM, INCLUDING FOUNDATION	EA

Supplemental Technical Specification for

Signal Heads

SCDOT Designation: 686.1

1.1 Description

This work shall consist of furnishing and installing Signal Heads, LED Modules or Backplates of the types, sizes, and mounting specified, in accordance with these Specifications, the plans and in accordance with the Standard Drawings (686-000-01, 686-100-01, 686-100-02, 686-100-03, and 686-100-05).

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Signal Heads.
- The Contractor shall furnish the ENGINEER with any warranties on materials provided by the Manufacturer or Vendor as normal trade practice, including a minimum 5-year warranty for the LED modules.
- In addition, the Contractor shall provide a EIGHTEEN (18) MONTHS workmanship warranty following the FINAL ACCEPTANCE. If any signal head fails by reason of defective material or workmanship, including cracking, falling, peeling or fading, the Contractor shall furnish and install replacement signal heads at no expense to the Department.
- Signal LED modules shall have the incandescent look. Pixelated LED modules shall be supplied as replacement modules only as directed by the ENGINEER.
- The red section in the five section head shall be powder coated.
- Provide fully assembled Signal Heads with LED Modules and the appropriate mounting hardware
- Install Signal Heads where shown on the plans and positioned in accordance with the Standard Drawings.
- Ensure the top section of all vehicle signal heads mounted on the same pole or pedestal is within 6 inches of being the same height unless otherwise specified.
- Install all multi-section/ combination signal heads with their top sections at the same elevation as other signal heads.

1.3.2 Wiring

- Connect electrical cable to the terminals in each signal head to provide the proper display indication.
- Do not externally splice the cable.
- Run electrical cable in accordance with the Standard Drawings.

1.3.3 Mounting

- Provide mounting hardware that is from one manufacturer. The DEPARTMENT will not accept mix-matched mounting assembly parts.
- Tighten mounting assembly to manufacturer standards prior to installing.
- If overhead adjustments are required for aiming, contractor shall field tighten using spanner wrench; Contractor shall ensure that signal heads are securely mounted on span wire or mast arms.

- Mount all traffic signal heads as shown on the plans and in accordance with the Standard Drawings.
- Aim signal faces to ensure good visibility, and to the satisfaction of the ENGINEER.

1.3.4 Signal Backplate

- Fasten Signal Backplates using appropriate hardware recommended by the signal head manufacturer.
- Provide a Signal Backplate that matches signal head without cutting, bending, or breaking. Drilling holes to match screw patterns is acceptable.
- Provide a Signal Backplate in accordance with Standard Drawing.

1.4 Measurement

- The pay items for furnish and install Signal Heads will be measured using the EACH unit and includes furnishing and installing Signal Heads with LED modules as specified on the plans and including ALL mounting hardware, internal electrical connections and ALL required incidental hardware.

1.5 Payment

6865710	Furnish and Install 12" 5 Section Signal Head	EA
6865720	Furnish and Install 12" 4 Section Signal Head	EA
6865723	Furnish and Install 12" 3 Section Signal Head	EA
6865834	FURNISH & INSTALL BACKPLATE W/ RETROREFL.BORDERS FOR TRAFFIC SIGNAL	EA

Supplemental Technical Specification for

Pedestrian Signal Head

SCDOT Designation: 686.3

1.1 Description

This work shall consist of furnishing and installing Pedestrian Signal Heads, Pedestrian LED Modules of the types, sizes, and mounting specified, in accordance with these Specifications, the plans and in accordance with the Standard Drawings. (675-105-02, 675-105-03, 675-110-00).

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Pedestrian Signal Heads.
- The Contractor shall furnish the ENGINEER with any warranties on materials provided by the Manufacturer or Vendor as normal trade practice, including a minimum 5-year warranty for the LED modules.
- In addition, the Contractor shall provide a EIGHTEEN (18) MONTHS workmanship warranty following the FINAL ACCEPTANCE. If any pedestrian signal head fails by reason of defective material or workmanship, including cracking, falling, peeling or fading, the Contractor shall furnish and install replacement pedestrian signal heads at no expense to the Department.
- Pedestrian Signal LED modules shall have the incandescent look. Supply pixelated LED modules as replacement modules only as directed by the ENGINEER.
- The pedestrian head and the mounting hardware are stated as one item.
- Install pedestrian signal heads where shown on the Plans or as needed to accommodate pedestrian movements.
- If multiple Pedestrian Signal Heads are required on the same pole or pedestal, mount within 6 INCHES of being the same height unless otherwise specified on the Plans.
- Mount Pedestrian Signal Heads so that no portion of the assembly is closer than 24 INCHES to the face of the curb.
- Mount Pedestrian Signal Heads to provide a clearance of 9 to 10 feet from the surface grade.

1.3.2 Wiring

- Connect electrical cable to the terminals in each Pedestrian Signal Head to provide the proper display indication when energized by the signal controller.
- Do not externally splice the cable.
- Run electrical cable in accordance with the Standard Drawings.

1.3.3 Mounting

- Use non-corrosive material in all hardware.
- Use FEDERAL YELLOW painted brackets, arms, and other hardware, unless noted otherwise in the plans or special provisions.
- Mount all pedestrian signal heads as shown on the Plans and Standard Drawings.

- See Standard Drawings for mounting information on Clamshell Mount, Side of Pole Mount, Single Post Top Mount, and Dual Post Top Mount.

1.4 Measurement

- The pay items for furnish and install Pedestrian Signal Heads will be measured using the EACH unit and includes furnishing and installing Pedestrian Signal Heads with LED modules as specified on the plans and including ALL mounting hardware, internal electrical connections and ALL required incidental hardware.
- There are separate pay items for furnishing and installing Pedestrian LED modules in existing pedestrian signal heads using the EACH unit.

1.5 Payment

6865782	FURNISH & INSTALL PEDESTRIAN SIGNAL HEAD	EA
6865783	FURNISH & INSTALL COUNTDOWN PEDESTRIAN SIGNAL HEAD	EA

Supplemental Technical Specification for

Pedestrian Push Button Station Assembly with Sign

SCDOT Designation: 686.4

1.1 Description

This work shall consist of furnishing and installing a PEDESTRIAN PUSH BUTTON STATION ASSEMBLY AND PUSH BUTTON SIGN, of the types, sizes, and mountings specified in accordance with these Specifications, at locations shown on the Plans and in accordance with the Standard Drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Pedestrian Push Button Assembly.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.
- Install Push Button Station Assemblies where shown on the Plans, or as necessary to accommodate pedestrian movements.

1.3.2 Installation

- Install Push Button Station Assemblies on poles in a height of 3-1/2 to 4 feet ABOVE GRADE.
- Orient and wire the Push Button Station Assembly in such a manner to clearly indicate to the pedestrian, the crosswalk with which it is associated.
- Attach Push Button Station Assemblies to poles using 1 inch stainless steel bands or galvanized screwed directly to pole.
- If dual push button station assemblies are required, a single dual mounting bracket shall be used to allow for two push button station assemblies to be mounted with the buttons positioned below the sign.
- Firmly secure the finished assembly to the pole.
- Connect each Push Button Station Assembly with the appropriate electrical cable, and wire to actuate the proper phase of the controller. The necessary cable is specified as a separate item, in accordance with 677.1 ELECTRICAL CABLE.
- Do not splice the cable.
On metal poles, bring the cable for the push buttons through the rear of the assembly directly into the pole or controller cabinet. On wooden poles, use electrical conduit to bring the cable to the assembly.

1.3.3 Push Button Signs

- Install each push button sign on the station assembly to reflect the proper intention of the pedestrian movement.

1.4 Measurement

- The pay items for furnish and install Push Button Station Assembly with Sign will be measured using the EACH unit and includes furnishing and installing the Push Button, Push Button

Assembly and Sign as specified on the plans and including ALL mounting hardware, internal electrical connections and ALL required incidental hardware.

1.5 Payment

6865793	FURNISH & INSTALL PEDESTRIAN PUSH BUTTON MICROSWITCH TYPE STATION ASSEMBLY (9"x12") AND SIGN (R-10-3E)	EA
6865794	FURNISH & INSTALL PEDESTRIAN PUSH BUTTON MICROSWITCH TYPE STATION ASSEMBLY (9"x15") AND SIGN (R-10-3E)	EA
6865796	FURNISH & INSTALL PEDESTRIAN PUSH BUTTON SOLID STATE WITH LIGHT AND TONE STATION ASSEMBLY (9"x12") AND SIGN (R-10-3E)	EA
6865797	FURNISH & INSTALL PEDESTRIAN PUSH BUTTON SOLID STATE WITH LIGHT AND TONE STATION ASSEMBLY (9"x15") AND SIGN (R-10-3E)	EA
6865798	FURNISH & INSTALL PEDESTRIAN PUSH BUTTON SOLID STATE WITH LIGHT AND TONE	EA

Supplemental Technical Specification for

LED Blankout Sign

SCDOT Designation: 686.5

1.1 Description

This work shall consist of furnishing and installing a LED Blankout Sign of Clam-Shell configuration, with Sun Visor and designated mounting hardware. of the types, sizes, and mounting specified, in accordance with these Specifications, the plans and in accordance with the Standard Drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to LED Blankout Sign.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.
- The Blankout Sign and the mounting hardware are stated as one item.
- Install the Blankout Signs where shown on the Plans, positioned according to the Standard Drawings.
- Hang Blankout Sign to ensure good visibility, to the satisfaction of the Engineer.

1.3.2 Wiring

- Connect electrical cable to the terminals in each Blankout sign to provide the proper display indication.
- Do not externally splice the cable.
- Run electrical cable in accordance with the Standard Drawings.
- Electrical cable shall be splice-free lengths of, NO. 14 COPPER WIRE, 4 CONDUCTOR, BLACK, see 677.1 Electric Cable

1.3.3 Mounting

- Use hardware that is non-corrosive material, or chemically compatible with the item being used.
- Use adjustable signal brackets to rigidly mount Blankout Signs.
- Use brackets and suspensions that are painted Federal YELLOW unless directed otherwise by the Engineer (Except mast arm mounts).
- Mount all Blankout Signs as shown on the Standards Drawings.

1.4 Measurement

- The pay items for furnish and install Blankout Signs will be measured using the EACH unit and includes furnishing and installing Blankout Sign housing, with appropriate LED module as specified on the plans and including ALL mounting hardware, internal electrical connections and ALL required incidental hardware.

- There are separate pay items for furnishing and installing Blankout LED modules in existing Blankout sign housing using the EACH unit and includes weather tight neoprene gasket and any other hardware or material necessary to complete installation.

1.5 Payment

6865820	FURNISH & INSTALL NO RIGHT/LEFT TURN SYMBOLIC LED BLANKOUT SIGN W/ SPAN WIRE MOUNTING	EA
6865821	FURNISH & INSTALL NO RIGHT/LEFT TURN SYMBOLIC LED MODULE	EA

Supplemental Technical Specification for

Removal Salvage and Disposal of Equipment and Materials

SCDOT Designation: 688.1

1.1 Description

This work consists of the removal and salvage or removal and disposal of equipment, materials or refuse that are not designated or permitted to remain. The engineer will instruct the contractor of what equipment or materials will be salvaged and where the contractor should deliver salvaged equipment/materials. The engineer will instruct the contractor of what equipment, materials and refuse to be disposed of. Contractor will dispose of these items in a manner that complies with all state and federal regulations governing disposal.

1.2 Materials

n/a

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Removal, Salvage and Disposal of Equipment and Materials.
- Carefully remove the items to be salvaged from the job site and return to the Department. The Contractor shall deliver, and obtain a RECEIPT for, the salvaged equipment, to one of the SCDOT District Signal Shops or one of the Local Government Signal Shops ([see link](#))
- Remove equipment or material to be Disposed and properly dispose 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).
- Any equipment or material to be Disposed shall not be re-sold by contractor as anything other than scrap material.
- Fill every hole caused by removing old equipment on THE SAME DAY. Back-fill, compact, and reseed/sod, to the satisfaction of the ENGINEER. Cleanly side-trim holes in PAVEMENT then bring to grade and finish with the same paving material as the adjacent pavement. Completely replace sidewalk "squares" (complete square), using forms and expansion material.
- Underground conduit and detector loops not utilized, shall be abandoned in place.
- 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 SCDOT or Local Government showing that the salvaged equipment has been delivered to SCDOT.

1.3.2 Items that are generally Removed and Disposed of:

1.3.2.1 Concrete foundations

- Remove the foundations of ground-mounted cabinets completely. The Engineer may direct the contractor to clear the foundation to a minimum depth of 18 inches below surface grade.
- Remove the foundations of signal support poles completely. The Engineer may direct the contractor to clear the foundation to a minimum depth of 18 inches below surface grade.

1.3.2.2 Damaged Equipment

- Remove and Dispose any signal equipment/material that is deemed by the Engineer as damaged beyond salvaging.

1.3.2.3 Miscellaneous Equipment

- Remove minor equipment from the site and dispose.
- This includes steel cable, electrical cable, conduit, concrete pads, back guys and pullboxes / handboxes not utilized in the new signalization.

1.3.3 Items that are determined whether to Salvage or Disposed of in the field by the Engineer

1.3.3.1 Wood Poles

- Remove Wood Poles that are not utilized in the new signalization and are not required by other utilities
- The ENGINEER shall make the determination whether each wooden pole shall be salvaged or disposed.
- If wood pole is to be salvaged, tag it with information concerning what location it was removed from.

Items that are generally Removed and Salvaged

1.3.3.2 Cabinet Assembly

- Prior to removal, clearly tag every cabinet, controller, conflict monitor, and any other major cabinet equipment item with the intersection name from which it is being removed. (*Fiber interconnect center, video detection cabinet equipment, Ethernet switch, fiber modem, radio cabinet equipment*)
- Record serial numbers for each cabinet, controller, and conflict monitor serial numbers and transmit to the Department.

1.3.3.3 Signal Heads

- Prior to removal, clearly tag each signal head with the intersection name from which it is being removed.
- Carefully dismounted signal heads keeping as much of the mounting hardware intact as possible.
- During the removal and delivery, take special care to prevent damage to the lenses and visors.

1.3.3.4 Pedestrian Equipment

- Prior to removal, clearly tag each pedestrian head, pedestrian pole and pedestrian button assembly with the intersection name from which it is being removed.
- Carefully dismount pedestrian heads and button assemblies keeping as much of the mounting hardware intact as possible.
- Ensure removal of pedestal pole includes related hardware (nuts, base).
- During the removal and delivery, take special care to prevent damage to the lenses and visors.

1.3.3.5 Metal Poles

- Prior to removal, clearly tag each steel strain pole with the intersection name from which it is being removed.
- Ensure removal of strain poles includes their related hardware (pole caps, bolt covers, hand hole covers, nuts, transformer bases, etc.).
- Bag related hardware and attach to steel strain pole and pedestrian pole to ensure materials remain together.

1.3.3.6 Splice Boxes

- Prior to removal, clearly tag each splice box with the intersection name from which it is being removed.

1.3.3.7 Signs

- Remove and salvage highway signs on existing span wires after the replacement signs have been installed

1.4 Measurement

This item shall be paid as a lump sum per contract or as an each, which relates to remove, salvage, disposal items per signal. The lump sum pay item includes all signals named in the contract. Costs relating to transportation, disposal, pavement and grading repairs should be included in pay item. The cost for removing foundations for steel strain poles is either provided as lump sum (which is all removals needed per contract) or each, which is all removals needed per steel strain pole foundation removal. 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.

1.5 Payment

6885990	REMOVAL, SALVAGE,& DISP.OF EXISTING TRAF. SIGNAL EQUIPMENT	LS
6885991	REMOVAL, SALVAGE,& DISP.OF EXISTING TRAF. SIGNAL EQUIPMENT	EA

6885982	REMOVE FOUNDATION OF STEEL STRAIN POLE - 18" BELOW GRADE	LS
6887941	REMOVE FOUNDATION OF STEEL STRAIN POLE - 18" BELOW GRADE	EA

Supplemental Technical Specification for

Temporary Adjustment of Traffic Signal Equipment and Timings

SCDOT Designation: 688.2

1.1 Description

1.1.1 General

This work consists of the Temporary Adjustment of traffic control signal equipment and materials during the construction of the project. 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, detection, etc. This item is also used to cover the installation and removal of a TEMPORARY CONSTRUCTION SIGNAL.

Temporary Adjustment may be necessary at all signalized intersections within the limits of the construction project. 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 Contractor should carefully study the Plans and Specifications to understand the work required.

1.1.2 Continuity of Signal Operation

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. Full Continuity of Operation shall be maintained by the CONTRACTOR and temporary signal devices shall be in place prior to construction activities that will affect signal operation. Damage to or failure of the existing traffic detection during the project shall be repaired by the CONTRACTOR, in accordance with Table 1.

Signals shall NOT be arbitrarily turned off for the convenience of the CONTRACTOR. When the Department gives permission to briefly turn off a signal, complete intersection control using a flagger and/or Police to direct traffic shall be provided.

Any damage to or failure of the detection of High Priority intersections shall require the contractor to be onsite and ACTIVELY repairing or replacing the detection with temporary detection within THIRTY-SIX (36) HOURS. The CONTRACTOR shall provide temporary detection equipment until the final detection is installed and operational. Upon installation of the final detection equipment, the CONTRACTOR shall remove the temporary detection equipment. If the temporary detection equipment will be used as the permanent detection equipment in the final configuration, payment will be made for both TEMPORARY

ADJUSTMENT OF TRAFFIC SIGNAL EQUIPMENT and the applicable permanent detection pay items.

Traffic Adaptive and Traffic Responsive signal systems shall maintain detection for the life of the project. Any damage to or failure of the detection of these systems shall require the contractor to be onsite and ACTIVELY repairing or replacing the detection with temporary detection within FOUR (4) HOURS. At traffic signals using wireless detection, which could be damaged by the project, the CONTRACTOR shall remove the roadway sensors and install temporary detection prior to construction activities. The CONTRACTOR shall ensure the roadway sensors for the wireless detection is replaced in the specific lane and location for which it is coded.

The table below details the requirements for all signalized intersections and the associated liquidated damages for failure to re-establish detection.

Table 1:

Intersection Type (as identified in Plans or Special Provisions)	Contractor Onsite and Actively Re-establishing Detection	Temporary Adjustment Pay Item	Permanent Detection Pay Item	Liquidated Damages for Failure to Perform / Maintain Detection
Adaptive/Responsive	4 hours	6885993	Per Contract	\$1500 per Intersection per day
High Priority	36 hours	6885993	Per Contract	\$1500 per Intersection per day
All others	14 days	1071000	Per Contract	\$1500 per Intersection per day

The CONTRACTOR shall coordinate installation and removal of temporary detection equipment with the Department's designated signal inspectors.

Unless noted otherwise on the Plans or stated in the Special Provisions, it is not permissible to adopt "uncoordinated" operation of adjacent signals. Damage to the interconnection cable between adjacent signals shall be repaired immediately by the CONTRACTOR, at no cost to the Department

When necessary the District Traffic ENGINEER should be requested to provide temporary controller timing settings. 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**. This work shall include all intersections needing timing adjustments per site visit. Site shall be defined as project limits.

Temporary Signals shall be fully reliable, fully functional, and of professional appearance. This includes placing the signal heads at the proper HEIGHT above the road, correctly ALLIGNING the signal heads with the lanes of traffic, and placing the signal heads at the proper DISTANCE from the stop line (see SCDOT Standard Drawings). The installation of a temporary Controller shall include transferring operation while simultaneously turning off the old controller

1.1.3 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.

1.1.4 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.

1.1.5 Operation, Maintenance and Emergency Service (as indicated in 675 General Provisions)

There is no separate pay item for Operation, Maintenance and Emergency Service. However, it is required as part of the contract for projects that involve signal construction or operations.

1.1.6 Specific Items

1.1.6.1 Possession

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

1.1.6.2 Signal Heads

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.

1.1.6.3 Poles

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

1.1.6.4 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 poles as necessary for Continuity of Operation. Back Guys shall be provided for wood poles to sufficiently keep the pole vertical.

1.1.6.5 Temporary Detection

Temporary Detection may include microwave, infrared, sonic, magnetometers, video, or inductance loops. The equipment shall be installed per the manufacturer's specifications. Temporary detection equipment shall be compatible with the traffic signal equipment, but shall not reside on the SCDOT network.

1.1.6.6 Detector Loops

Final Detector Loops shall only be installed after completion of all work activities which might damage the inductance loops.

1.1.6.7 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, temporary detection, 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.

1.1.6.8 Signs

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

1.1.6.9 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 Department is the responsibility of the CONTRACTOR, as well as, all permits and licenses.

1.1.6.10 Communication Service

The CONTRACTOR shall maintain communication service(s) as necessary to operate the signal(s). Communications between the signal(s) and the SCDOT NETWORK in accordance with ITS standards shall be kept at all times.

1.2 Measurement

Temporary Adjustment of Traffic Signal Equipment will be measured as EACH, one per intersection for the life of the project. This includes adjustment of traffic signal equipment (signal heads, overhead signs, span wire, etc.), and installation of temporary signal equipment (signal heads, detection, poles, etc.) impacted or necessitated by Construction Operations, as often as necessary.

Temporary Timing Adjustments will be measured as EACH. This work shall include all intersections needing timing adjustments per site visit which signal timings are properly adjusted as directed. Site shall be defined as project limits.

The CONTRACTOR shall provide all signal materials and related equipment to adjust these features as often as necessary during the course of the project.

1.3 Payment

Temporary Adjustment of traffic signals shall be paid at the line item Contract price. The line item includes the Installation AND Removal of all temporary traffic signal equipment:

6885993	TEMPORARY ADJUSTMENT OF TRAFFIC SIGNAL EQUIPMENT	EA
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Temporary Timing Adjustment of traffic signals shall be paid at the line item Contract price:

6885996	TEMPORARY TIMING ADJUSTMENTS PER SITE VISIT	EA
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Pay Item Notes

This specification is not limited to these pay items. Other pay items may be applicable.

Supplemental Technical Specification for

Video Detection System

SCDOT Designation: 688.3

1.6 Description

This work consists of furnishing and installing video detection systems with all necessary hardware and software in accordance with the plans and Standard Drawings.

1.7 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.8 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Video Detection System.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.
- Arrange and conduct site surveys with SCDOT personnel to determine proper camera sensor unit selection and placement.
- Provide SCDOT at least 3 working days notice before conducting site surveys.
- Upon completion of the site surveys, provide SCDOT with revised plans reflecting the findings of the site survey.
- As determined during the site survey, install sensor junction boxes with nominal 6 x 10 x 6 inches dimensions at each sensor location. Provide terminal blocks and tie points for power cable
- Place into operation loop emulator detection systems. Configure loop emulator detection systems to achieve required detection in designated zones. Have a certified manufacturer's representative on site to supervise and assist with installation, set up, and testing of the system.
- Perform modifications to camera sensor unit for gain, sensitivity, and iris limits necessary to complete the installation.
- Do not install camera sensor units on signal poles unless approved by the ENGINEER
- Install a power cable appropriately sized to meet the power requirements of the sensors. At a minimum, provide three conductor 120 VAC field power cable.
- Install the necessary cables from each sensor to the signal controller cabinet along signal cabling routes.
- Install surge protection where coaxial video cables and other cables are required between the camera sensor and other components located in the controller cabinet. Terminate all cable conductors.
- Relocate camera sensor units and reconfigure detection zones as necessary according to the plans for construction phases.

1.9 Measurement

- Furnishing and Install Video Detection System shall be measured as EACH unit and shall include one camera, the cabinet equipment, and all mounting hardware and necessary cable to connect camera to cabinet equipment.
- Furnish and Install Add'l Camera with Hardware & Lead In shall be measured as EACH unit and includes furnishing and installing 1 camera and all mounting hardware and necessary cables to connect to cabinet equipment.

1.10 Payment

6886039	FURNISH & INSTALL VIDEO DETECTION CAMERA MOUNTING HARDWARE	EA
6886040	FURNISH & INSTALL VIDEO DETECTION SYSTEM W/HARDWARE & LEAD-IN	EA
6886041	INSTALL VIDEO DETECTION SYSTEM	EA
6886042	FURNISH & INSTALL VIDEO DETECTION CAMERA W/ HARDWARE & LEAD-IN	EA

Supplemental Technical Specification for

Radar Detection System

SCDOT Designation: 688.4

1.1 Description

1.1.1 General

This work shall consist of furnishing and/or installing a Radar Detection System (RDS) to detect vehicles on a roadway by transmitting electromagnetic radar signals through the air. The signals bounce off vehicles in their paths and part of the signal is returned to the Radar Detection System. The returned signals are then processed to determine traffic parameters. A Radar Detection System (RDS) shall interface with a 170 Traffic Signal Controller cabinet/ 2070 Controller. The system shall be installed per the manufacturers recommended installation requirements.

The Radar Presence Detector (RDS) system will include the following equipment:

- Radar Units (Stop bar radar, Set back radar, Speed/volume side-fire radar)
 - Sensor Outputs
 - Enclosure
- Radar Cabinet Interface
 - System Hardware
 - Interface panel
 - Contact closure input file cards
 - Communication ports
 - Software
- Sensor Cable

1.1.2 Maintenance

- The RDS shall not require cleaning or adjustment to maintain performance.
- The RDS shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement. Once the RDS is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes. The mean time between failures shall be 10 years.

1.1.3 Operating Conditions

- The RDS shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.
- RDS operation shall continue in rain up to 1 in. (2.5 cm) per hour.
- The RDS shall be capable of continuous operation over an ambient temperature range of -40°F to 165.2°F (-40°C to 74°C). The RDS shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).

1.1.4 Manufacturing

- The RDS shall be manufactured and assembled in the USA.
- The internal electronics of the RDS shall utilize automation for surface mount assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies.

- The RDS shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:
 - Functionality testing of all internal sub-assemblies
 - Unit level burn-in testing of 48 hours' duration or greater
 - Final unit functionality testing prior to shipment
- Test results and all associated data for the above testing shall be provided for each purchased RDS by serial number, upon request.

1.1.5 Certification

- Each RDS shall be certified by the Federal Communications Commission (FCC) under CFR 47, part 15, section 15.249 as an intentional radiator.
- The FCC certification shall be displayed on an external label on each RDS according to the rules set forth by the FCC. The RDS shall comply with FCC regulations under all specified operating conditions and over the expected life of the RDS.

1.1.6 Support

Contractor shall ensure the RDS manufacturer provides both training and technical support services.

1.1.7 Training

The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the RDS to ensure accurate RDS performance as specified in 689.3 Traffic Signal System Training of the Traffic Signal Supplemental Specifications.

1.1.8 Network Compatibility

RDS must be approved by SCDOT IT Department to reside on SCDOT Traffic Signal Communications Network. For the protection of the SCDOT, all networkable devices are required to be hardened and secured using an industry standard. SCDOT uses the National Institute of Standards and Technology Cybersecurity framework, but recognizes that other comparable frameworks and standards exist. Among these frameworks are:

- NIST RMF
- NIST CSF
- ISO IES 27001/ISO 27002
- SOC 2
- IASME Governance
- CIS Controls version 7
- COBIT 5
- FedRAMP
- HIPAA
- GDPR
- FISMA
- NERC CIP
- HITRUST CSF

1.1.9 Warranty

There shall be a two-year warranty provided against material and workmanship defects.

1.2 Materials

1.2.1 Radar Detection System (Radar Units, Radar Cabinet Interface, Cable)

- Radar Operating frequency of 24.0 to 24.25 GHz (K-band) utilizing a matrix of radars
- Two half-duplex RS-485 com ports with dedicated detection communication
- Power consumption less than 10 watts @ 9-28 VDC
- Ambient operating temperature: -29°F to 165°F with humidity: Up to 95% RH
- Must have Onboard surge protection
- Weight less than 5 lbs. (2.27 kg)

1.2.2 Radar Unit Types

1.2.2.1 Stop Bar Detection Units

- The RDS shall present real-time presence data in 10 lanes. The RDS shall support a minimum of 16 zones.
- The RDS shall support a minimum of 16 channels.
- The RDS shall be able to detect and report presence in lanes with boundaries as close as 6 ft. (1.8 m) from the base of the pole on which the RDS is mounted.
- The RDS shall be able to detect and report presence in lanes located within the 140 ft. (42.7 m) arc from the base of the pole on which the RDS is mounted.
- The RDS shall be able to detect and report presence for vehicles within a 90-degree field of view.
- The RDS shall be able to detect and report presence in up to 10 lanes.
- The RDS shall be able to detect and report presence in curved lanes and areas with islands and medians.
- The RDS shall work in the 24GHz frequency range, providing 245 MHz of detection bandwidth.

1.2.2.2 Set Back Advance Detection Units

- The Set Back RDS shall provide up to 900' detection zone for trucks, and up to 600' for cars.
- The Set Back RDS shall provide detection at 50' from mounting with a 50' lateral detection zone.
- The Set Back RDS Detection unit shall work in the 10 GHz frequency range or higher.
- The Set Back RDS shall provide continuous tracking from initial detection point to the intersection.
- The Set Back RDS shall provide dynamic Estimated Time of Arrival ETA, to the intersection, providing dilemma zone protection as an optional functionality.

1.2.2.2 Speed/Volume Side-Fire Detection

- The Speed/Volume Side-Fire RDS shall provide detection for speed and volume data collected by lane for minimum of 10 lanes of multi-directional traffic
- The Speed/Volume Side-Fire RDS shall provide detection from 6' from mounting up to 250' in a 65 degree vertical field of view.
- The Speed/Volume Side-Fire RDS shall work in the 24 GHz frequency range, providing 245 MHz of detection bandwidth.

1.2.3 Radar Unit Properties

1.2.3.1 Sensor Outputs

- The RDS shall support user-selectable zone to channel mapping.
- The RDS shall be able to trigger channels when all selected zones are active.
- The RDS shall be able to combine multiple zones to a channel output, and shall have channel output extend and delay functionality.
- The RDS algorithms shall mitigate detections from wrong way or cross traffic.

- The RDS system shall have fail-safe mode capabilities for contact closure outputs if communication is lost

1.2.3.2 External Properties

- All external parts of the RDS shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration.

1.2.3.3 Enclosure

- The RDS shall be enclosed in a Lexan EXL polycarbonate.
- The enclosure shall be classified "f1" outdoor weather ability in accordance with UL 746C. The RDS shall be classified as watertight according to the NEMA 250 standard.
- The RDS enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test result shall be provided for each of the following type 4X criteria:
 - External icing (NEMA 250 clause 5.6)
 - Hose-down (NEMA 250 clause 5.7)
 - 4X corrosion protection (NEMA 250 clause 5.10)
 - Gasket (NEMA 250 clause 5.14)
- The RDS shall be able to withstand a drop of up to 5 ft. (1.5 m.) without compromising its functional and structural integrity.
- The RDS enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

1.2.3.4 Radar Design

- The RDS shall be designed with multiple radars, enabling the sensor to provide detection over a large area and to discriminate lanes for stop bar radar and side-fire radar accuracy.

1.2.3.5 Frequency Stability

- The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.
- All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any up conversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.
- The RDS shall not rely on temperature compensation circuitry to maintain transmit frequency stability.
- The bandwidth of the transmit signal of the RDS shall not vary by more than 1% under all specified operating conditions and over the expected life of the RDS.

1.2.3.6 Antenna Design

- The RDS antennas shall be designed on printed circuit boards.
- The vertical beam width of the RDS at the 6 dB points of the two-way pattern shall be 65 degrees or greater. The antennas shall cover a 90-degree horizontal field of view.
- The side lobes in the RDS two-way antenna pattern shall be -40 dB or less.

1.2.3.7 Resolution

- The RDS shall transmit a signal with a bandwidth of at least 245 MHz.

1.2.4 Radar Cabinet Interface

1.2.4.1 System Hardware

- Each RDS shall have a traffic cabinet preassembled backplate or integrated cabinet device with the following:

- AC/DC power conversion
- Surge protection
- Terminal blocks for cable landing
- Communication connection points
- Ethernet TCP/IP communication
- SDLC (Optional) communication
- The preassembled backplate for the RDS shall be a cabinet side mount or rack mount.
- The integrated cabinet device for the RDS shall be a shelf mount with an option to cabinet side mount.

1.2.4.2 Contact Closure Input File Cards

- The RDS shall use contact closure input file cards with 2 or 4 channel capabilities.
- The contact closure input file cards for the RDS shall be compatible with industry standard detector racks.

1.2.4.3 Electrical

- The RDS shall consume less than 10 W.
- The RDS shall operate with a DC input between 10 VDC and 28 VDC. The RDS shall have onboard surge protection.

1.2.4.4 Communication Ports

- The RDS shall have two communication ports, and both ports shall communicate independently and simultaneously.
- The RDS shall support the upload of new firmware into the RDS's over either communication port. The RDS shall support the user configuration of the following:
 - Response delay
 - Push port
- The communication ports shall support a 9600 bps baud rate.

1.2.4.5 RF Channels

- The RDS shall provide at least 8 RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

1.2.4.6 Verification

- The RDS shall have a self-test that is used to verify correct hardware functionality. The RDS shall have a diagnostics mode to verify correct system functionality.

1.2.4.7 Configuration

- *Auto-configuration.* The RDS shall have a method for automatically defining traffic lanes, stop bars and zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RDS and shall not require an external PC or other processor.
The auto-configuration process shall work under normal intersection operation and may require several cycles to complete.
- *Manual Configuration.* The auto-configuration method shall not prohibit the ability of the user to manually adjust the RDS configuration.
The RDS shall support the configuring of lanes, stop bars and detection zones in 1-ft. (0.3-m) increments. When lanes have variable widths or have variable spacing (e.g. gore between lanes), precise resolution is necessary.

1.2.4.8 Software Compliance

- The RDS shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic representation.
- The RDS shall include the ability to do counting and pulsed channels.
- The graphical interface shall be Microsoft Windows compliant.
- The software shall be installed and operate on a SCDOT provided Windows operating system.
- The software shall support the following functionality:
 - Operate over a TCP/IP connection
 - Give the operator the ability to save/back up the RDS configuration to a file or load/restore the RDS configuration from a file
 - Allow the backed-up sensor configurations to be viewed and edited
 - Provide zone and channel actuation display
 - Provide a virtual connection option so that the software can be used without connecting to an actual sensor.
- Local or remote sensor firmware upgradability.

1.2.4.9 Sensor Cable

- The cable shall be the Orion Wire Combo-22042002-PVCGY or an equivalent cable that conforms to the following specifications:
 - 6-conductor cable that attaches to an 8-pin MIL-C-26482 connector
 - The RS-485 conductors shall be 2 twisted pairs.
 - The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 40 pF/ft at 1 kHz.
 - The RS-485 conductors shall have nominal conductor DC resistance of less than 16.7 ohms/1000 ft. at 68°F.
 - The power conductors shall be a twisted pair.
 - The power conductors shall have nominal conductor DC resistance of less than 11 ohms/1000 ft. at 68°F.
 - The entire cable shall be shielded with an aluminum/mylar shield with a drain wire.
 - The cable shall have a diameter of 0.41 in. The power wires in the cable shall be 20 AWG; the communications wires shall be 22 AWG.
 - The cable shall be UV resistant, as per the UL 720 Hour Sunlight Resistance Test

1.3 Construction

- Installation shall be in accordance with manufacturer's instructions.
- Mounting hardware for RDS's will not drill into the existing signal support poles.
- Cable will be continuous from RDS to the controller cabinet.
- Contractor shall provide post installation testing to the Engineer for consideration and approval.
- Stop bar detection RDS shall be mounted between 15' - 35' on a vertical pole or mast arm.
- Setback detection RDS shall be mounted between 17' - 40' on a vertical pole or mast arm.
- Speed / volume detection RDS shall be mounted between 17' - 40' on a vertical pole or mast arm.

1.4 Measurement

Furnishing and/or Installing Components of a Radar Detection System shall be measured as EACH unit and includes all hardware and cables necessary for installation and operation, and license.

1.5 Payment

	FURNISH & INSTALL RADAR DETECTION SYSTEM for STOP BAR DETECTION INC. 150' CABLE & MOUNTING HARDWARE	EA
	FURNISH & INSTALL CABINET INTERFACE COMPONENTS for STOP BAR DETECTION	EA
	FURNISH & INSTALL RADAR DETECTION SYSTEM for SET BACK DETECTION INC. 150' CABLE & MOUNTING HARDWARE	EA
	FURNISH & INSTALL CABINET INTERFACE COMPONENTS for SET BACK DETECTION	EA
	FURNISH & INSTALL RADAR FOR SPEED/VOLUME DETECTION INC 150' CABLE & MOUNTING HARDWARE	EA
	FURNISH & INSTALL CABINET INTERFACE COMPONENTS for SPEED/VOLUME DETECTION	EA
	FURNISH & INSTALL RADAR DETECTION CABLE TO CROSS ROADWAY	LF

Supplemental Technical Specification for Steel Strain Pole and Foundation

SCDOT Designation: 688.5

1.1 Description

This work shall consist of furnishing and installing Steel Strain Poles for traffic signal supports at the locations shown on the Plans and in accordance with the Standard Drawings, with anchor bolts and all miscellaneous hardware. This work shall also consist of installing a foundation for the steel strain pole in accordance with the Standard Drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Steel Strain Pole.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.
- Repair galvanized surfaces (poles) which have been scratched or abraded so that bare metal is exposed, by applying 2 coats of 90% (minimum) Zinc-rich, cold-galvanizing compound; to the satisfaction of the ENGINEER.

1.3.2 Location

- Install the pole in the general location shown on the Plans.
- Coordinate with the Engineer to stake the field location of the pole, considering the property lines, underground utilities, and overhead clearances.
- ENGINEER will approve staked locations, however contractor is responsible for locating utilities.
- If utility conflicts are discovered, relocate pole in coordination with the Engineer's approval.
- The pole location may have to be moved based on unmarked utilities.

1.3.3 Foundation

- Drill a hole, as indicated in the Standard Drawings.
- The hole shall be augured (earth-auger), and the concrete poured in UN-disturbed earth.
- Ensure the hole is a uniform diameter, and cleanly augured.
- If foundation cannot be constructed to meet Standard Drawings, provide an alternative foundation design signed and sealed by a SC PE.
- It may be necessary to use a jack-hammer in BED-ROCK; it may be necessary to use a heavy walled CAISSON to line the hole and to pump it dry in high water table areas or areas where springs are encountered. These materials, tools and additional labor are incidental to the project.
- 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.
- Construct the foundation as shown in Standard Drawing 688-500-01 including the rebar cage and conduit.

- Mix, place, pour and test the concrete in accordance with SCDOT Standard Specifications, Sections 701, 702, 703, and 704.
- Provide CLASS 5000 for the foundation. Place the concrete in one continuous pour with vibration.
- Set the Anchor Bolts using pre-formed templates (wood or metal), to provide a "bolt-circle" in accordance with the Standard Drawings or with recommendations of the pole Manufacturer. Leave the templates in place for 2 days (48 hours).
- Capp conduit elbows at both ends, and secure in place in the excavated hole before pouring any concrete.
- Each foundation shall have a minimum of 1-3", 3-2" and 2-1" conduits placed in accordance with the Standard Drawings. Provide additional conduits if shown on the plans. These conduits are incidental to the work.
- Terminate all conduit provided in foundation in a 13"X24"X18"splice box; the splice box shall be installed in accordance with 680.2 Splice Boxes / Junction Boxes. The splice box shall be paid separately.
- Ensure all conduit elbows extend beyond the side of the finished foundation by a minimum of 12 inches, in the direction of, and at a depth matching the incoming conduit. Where a conduit elbow is placed for future use, scribe an "X" in the foundation to indicate the side where such conduit enters. Ensure the conduit protrudes a minimum of 6 inches above the top of the finished concrete foundation.

1.3.4 Grounding

- Furnish and install ground rods and grounding wire with each foundation.
- Configure the ground rod with the foundation, as shown on the Standard Drawings.
- Use grounding clamps of brass or bronze to secure the grounding wire to the ground rod.
- Use a continuous ground wire to bond all metal parts together--pole ground stud; pedestal pole nut; pole-mounted controller cabinet ground; metal conduits; etc.

1.3.5 Installation

- Do not place the steel pole on the foundation for a minimum of 2 days (48 hours after individual pour)
- Do not place strain on the steel pole for a minimum of 7 days (168 hours after individual pour) or as otherwise directed by the ENGINEER.
- Rake each pole away from the line of span wire pull, by adjusting the nuts on the Anchor Bolts.
- When final load is applied, ensure there is a 6 inch (plus or minus one inch) rake at the top of the pole, opposing the direction of the stress.
- Restore the site to prime condition after the pole installation, back filling the area surrounding the pole with topsoil, raking it level and seeding. If the area is sloped, then use landscape turf.

1.3.6 Sidewalk/Island Installation

- When installing the pole in a sidewalk, cleanly cut out the entire "square" of the sidewalk and install the foundation as indicated above.
- Replace the sidewalk using expansion joint material to separate different "pours" and old/new concrete. This work is incidental, unless an item has been established for CONCRETE PATCH or for SIDEWALK.
- In concrete islands, saw-cut out a square opening 4 feet x 4 feet for the pole base and repair as stated above.
- When installed in SIDEWALKS or CONCRETE ISLANDS, contour the entire area and hand-finish to produce a neat visual line. Sharp edges or pedestrian hazards shall not be allowed.

1.3.7 Acceptance

- Acceptance of each pole shall include foundation strength testing plus visual inspection by the ENGINEER.
- The visual inspection shall be made of the pole, overhead cables, and grounding.
- The complete installation shall be structurally sound, and the final pole placement shall be vertical, or raked as specified.

- Contractor shall replace any poles NOT meeting this inspection, without further cost to the project.

1.4 Measurement

- Furnishing and installing 13" Diameter Steel Strain Poles and Foundations, will be measured by EACH, of the size(s) specified, and erected in place as shown on the plans. This shall include foundation, anchor bolts, nut covers, pole cap, reinforcing steel, ground rod, ground wire, and all miscellaneous hardware as required.
- Installing Concrete Foundation for Steel Strain Pole, will be measured by each, shall include reinforcing steel, ground rod, ground wire, and all miscellaneous hardware as required.

1.5 Payment

682505A	FURNISH & INSTALL 26' STEEL STRAIN POLE AND FOUNDATION	EA
6825050	FURNISH & INSTALL 26' STEEL STRAIN POLE (POWDER COATED) AND FOUNDATION	EA
6825056	FURNISH & INSTALL 26' STEEL STRAIN POLE (POWDER COATED OVER GALVANIZED) & FOUNDATION	EA
682505B	FURNISH & INSTALL 28' STEEL STRAIN POLE AND FOUNDATION	EA
6825051	FURNISH & INSTALL 28' STEEL STRAIN POLE (POWDER COATED) AND FOUNDATION	EA
6825057	FURNISH & INSTALL 28' STEEL STRAIN POLE (POWDER COATED OVER GALVANIZED) AND FOUNDATION	EA
682505D	FURNISH & INSTALL 32' STEEL STRAIN POLE AND FOUNDATION	EA
6825052	FURNISH & INSTALL 32' STEEL STRAIN POLE (POWDER COATED) AND FOUNDATION	EA
6825058	FURNISH & INSTALL 32' STEEL STRAIN POLE (POWDER COATED OVER GALVANIZED) AND FOUNDATION	EA

Supplemental Technical Specification for

Concrete Strain Pole

SCDOT Designation: 688.6

1.1 Description

This work shall consist of furnishing and installing pre-stressed Concrete Strain Poles for traffic signal supports at the locations shown on the Plans and in accordance with the Standard Drawings, with all miscellaneous hardware. These poles shall be of the type intended for direct embedding, with the hole back filled with concrete.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Concrete Strain Pole.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice.
- Patch any concrete surfaces which have been chipped, chunked or damaged to the satisfaction of the ENGINEER with a commercial grade vinyl or epoxy based on concrete patching compound, according to manufacturer's instructions.
- CAUTION – Concrete poles are very heavy, quite long and are difficult to handle. Perform transportation, site handling and erection 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.

1.3.2 Location

- Install the pole in the general location shown on the Plans.
- Coordinate with the Engineer to stake the field location of the pole, considering the property lines, underground utilities, and overhead clearances.
- ENGINEER will approve staked locations, however contractor is responsible for locating utilities.
- If utility conflicts are discovered, relocate pole in coordination with the Engineer's approval.
- The pole location may have to be moved based on unmarked utilities.

1.3.3 Hole

- Augur the hole in undisturbed earth of the diameter and to the depth (at least) listed in the standard drawings or as recommended by the manufacturer (whichever is larger). Construct the embedding foundation as shown in Standard Drawing 688-600-01.
- Measure the depth and diameter of the hole with a tape measure to ensure it meets the required dimensions.
- If hole dimensions and backfill foundation cannot be constructed to meet Standard Drawings, provide an alternative foundation design signed and sealed by a SC PE.
- It may be necessary to use a jack-hammer in BED-ROCK; it may be necessary to use a heavy walled CAISSON to line the hole and to pump it dry in high water table areas or areas where springs

are encountered. In Wet-lands or loose-sand, it may also be necessary to auger a larger hole. These materials, tools and additional labor are incidental to the project.

- 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.
- 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 3 inch clearance all around the concrete pole.

1.3.4 Grounding

- Furnish and install ground rods and grounding wire with each concrete pole.
- Drive the ground rod adjacent to the poured concrete embedding as shown on the Standard Drawing.
- Use grounding clamps of brass or bronze to secure the grounding wire to the ground rod.
- Use a continuous ground wire to bond all metal parts together--pole ground stud; pedestal pole nut; pole-mounted controller cabinet ground; metal conduits; etc.

1.3.5 Installation

- Place the concrete pole in the hole.
- Lift the pole 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, insert a bar into the choker hole (1/3 down the pole)(to prevent the strap from slipping) and use a single strap to raise one end of the pole vertically and jostle the butt end into the hole.
- Lower the pole into the hole and hold vertically by the crane.
- Using a pry bar through the "CANT" hole, rotate the pole so that all holes are at the proper compass orientation angle with the street and incoming conduit runs.
- Rake each pole slightly 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.
- Backfill the hole back with concrete while supporting the concrete pole vertically with a pole or boom truck until the poured embedding concrete begins to set. This will typically be 15 to 20 minutes.
- Mix, place, pour and test the concrete in accordance with SCDOT Standard Specifications, Sections 701, 702, 703, and 704.
- Provide CLASS 3000 for the foundation; Place the concrete in one continuous pour.
- Plug/cover the underground cable entrance hole and any conduit openings to prevent concrete intrusion.
- 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.
- Capp at both ends and secure in place any conduit elbows in the excavation before pouring any concrete.
- Each foundation shall have a minimum of 1-3", 3-2" and 2-1" conduits placed in accordance with the Standard Drawings. Provide additional conduits if shown on the plans. These conduits are incidental to the work.
- Terminate all conduit provided in foundation in a 13"X24"X18"splice box; the splice box shall be installed in accordance with 680.2 Splice Boxes / Junction Boxes. The splice box shall be paid separately.
- Ensure all conduit elbows shall extend beyond the side of the finished foundation by a minimum of 12 inches in the direction of and at a depth matching the incoming conduit.
- Do not place stress (steel cables) on the pole until the poured embedding concrete has hardened (typically 72 hours).
- Restore the site to prime condition after the pole installation, back filling the area surrounding the pole with topsoil, raking it level and seeding. If the area is sloped, then use landscape turf.

1.3.6 Sidewalk/Island Installation

- When installing the pole in a sidewalk, cleanly cut out the entire “square” of the sidewalk and install the concrete pole embedded in poured concrete; back fill with tamped dirt to 4 inches below the ground line foundation as indicated above.
- Replace the sidewalk using expansion joint material to separate different "pours" and old/new concrete. This work is incidental, unless an item has been established for CONCRETE PATCH or for SIDEWALK.
- In concrete islands, saw-cut out a square opening 4 feet x 4 feet for the pole base and repair as stated above.
- When installed in SIDEWALKS or CONCRETE ISLANDS, contour the entire area and hand-finish to produce a neat visual line. Sharp edges or pedestrian hazards shall not be allowed.

1.3.7 Acceptance

- Acceptance of each pole shall include foundation strength testing plus visual inspection by the ENGINEER.
- The visual inspection shall be made of the pole, overhead cables, and grounding.
- The complete installation shall be structurally sound, and the final pole placement shall be vertical, or raked as specified.
- Contractor shall replace any poles NOT meeting this inspection, without further cost to the project.

1.4 Measurement

- Furnishing and installing concrete strain poles will be measured by EACH of the length specified. This shall include pole cap and all miscellaneous hardware as required.
- Conduit elbows shall be considered to be incidental to the installation of the concrete pole.

1.5 Payment

6825061	FURNISH & INSTALL 35' CONCRETE STRAIN POLE	EA
6825062	FURNISH & INSTALL 40' CONCRETE STRAIN POLE	EA
6825064	FURNISH & INSTALL 45' CONCRETE STRAIN POLE	EA

Supplemental Technical Specification for Controller and Cabinet Assembly

SCDOT Designation: 688.7

1.1 Description

This work shall consist of furnishing and installing Cabinet Assembly, Cabinet Foundation and Controller in accordance with these Specifications, at the locations shown on the Plans, and in accordance with the Standard Drawings. This item shall include all electrical accessories and other items specified.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Controller and Cabinet Assembly.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice or to match warranty on existing state contract items.

1.3.2 Concrete Foundation

- Construct the foundation to the dimensions shown on the Standard Drawing 688-700-01 Signal Cabinet – Base Mounted Cabinet.
- Set bolt pattern in accordance with the recommendations of the Cabinet Manufacturer.
- Set templates for setting anchor bolts and leave in place until the forms are removed.
- Concrete lag bolts drilled into pad are allowed.
- Mix, place and test concrete in accordance with applicable portions of SCDOT STANDARD SPECIFICATIONS Sections 701, 702, 703, and 704. Provide CLASS 3000 concrete.
- Set base mounted cabinets on a bead of silicone caulk.

1.3.3 Ground Rod and Ground Wire

- Furnish and install a ground rod and ground wire with each Cabinet.
- Place the 5/8 INCH by 8 feet (minimum) Copper-clad ground rods near the cabinet's concrete foundation, external to the cabinet pad in a splice box. If additional ground rods are required, place nearby and EXOTHERMICALLY WELD together.
- Place a 1-INCH PVC conduit and elbow in foundation prior to pouring as shown in the Standard Drawing.
- Run ground wires (No. 6 AWG bare, stranded copper wire) continuously from the ground rod to the Controller Cabinet (chassis ground on the AC ground bar) through this conduit; and run ground wires continuously from the ground rod to the foundation anchor bolts, to the conduit bends, etc.
- EXOTHERMICALLY WELD ground wires TO THE GROUND ROD.
- Use grounding bushings on metal conduit.
- For Cabinets mounted on strain poles, connect the grounding stud on the pole.
- The entire ground rod shall be driven below the grade or place in a junction box.

1.3.4 Conduit Elbows

- Do not encase the conduit entering the cabinet in concrete. (See Standard Drawing 688-700-01 Signal Cabinet – Base Mounted Cabinet)
- Set Conduit Elbows in the footing excavation before the concrete is poured.
- The size and number of elbows shall be that necessary to mate with the incoming runs and in accordance with the plans and the Standard Drawings. Run conduit in accordance with Standard Drawing 688-700-01 Signal Cabinet – Base Mounted Cabinet from pole to splice box and from pole to cabinet where the steel pole is adjacent to a base mounted cabinet.
- Conduit shall extend beyond the side of the finished foundation by a minimum of 12 inches, in the direction of, and at a depth matching the incoming conduit.
- The conduit shall extend beyond the top of the finished foundation into the pole or Cabinet, in accordance with Standard Drawings.
- Cover and protect the open-ends and threads on the conduit bends during construction activities.

1.3.5 Electrical Wiring

- Install all required equipment in the Cabinet, and neatly wire with tied or wrapped harnesses. Force-fitted or mutually interfering equipment is not acceptable.
- Label cable harnesses and terminals legibly.
- Terminate all bare wires in a "spade-lug" prior to connection to a terminal strip. 'Crimp-on' the "spade-lug" using a ratchet-type crimping tool.
- Tie wires not facilitating equipment movement to the back or side-panel.
- Install and position equipment for easy access.
- Ensure opening and closing the Cabinet door shall not chaff the wiring.
- Ensure the field (lamp) wiring shall have 3 feet of slack cable in each cabinet.
- Coil the slack and tie neatly in the bottom of the Cabinet.
- Separate signal cables from detector lead-in cables as much as possible, to reduce interference.

1.4 Measurement

- Local Controller and Cabinet furnished and/or 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.
- Furnishing and/or Installing a Concrete Cabinet Foundation will be measured by EACH and will include anchor bolts and all necessary hardware.

1.5 Payment

6845510	FURNISH AND INSTALL CONTROLLER AND 336 CABINET ASSEMBLY - POLE MOUNTED	EA
6845511	FURNISH AND INSTALL CONTROLLER AND 332/336 CABINET ASSEMBLY - BASE MOUNTED	EA
6888220	INSTALL CONTROLLER AND 336 CABINET - POLE MOUNTED	EA
6888225	INSTALL CONTROLLER AND 332/336 CABINET - BASE MOUNTED-INCLUDING FOUNDATION	EA
6888226	INSTALL CONTROLLER AND 332/336 CABINET ASSEMBLY-BASE MOUNTED CABINET ON EXISTING FOUNDATION	EA
6845520	FURNISH AND INSTALL 2070 CONTROLLER UNIT IN EXISTING CABINET	EA
6845614	INSTALL 2070 CONTROLLER UNIT &/OR CONFLICT MONITOR IN EXISTING CABINET	EA

6887951	FURNISH AND INSTALL CONCRETE CABINET FOUNDATION	EA
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Supplemental Technical Specification for

Flasher Cabinet Assembly

SCDOT Designation: 688.8

1.1 Description

This work shall consist of furnishing and installing Splice/Flasher Cabinet as indicated on the plans and in accordance with these Specifications and the Standard Drawings.

1.2 Materials

Acceptable materials for Flasher Cabinet Assembly includes an aluminum flasher box, complete with mounting brackets, police lock and key, minimum dimensions of 14" x 14" x 11". Flasher Cabinet Assembly shall have terminal lugs included. Flasher Cabinet Assembly shall be Pre-wired for Time Switch and include a back panel pre-wired for

- 8 position terminal block
- 10 amp circuit breaker
- SPA-100T lightning surge protector
- Toggle switch for a variety of operation times
- 30 amp isolation relay
- NEMA flasher.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Flasher Cabinet.
- The Contractor shall furnish the ENGINEER with any warranties on materials that are provided by the Manufacturer or Vendor as normal trade practice or to match warranty on existing state contract items.
- Provide all components or hardware made of corrosion-resistant material, or be of the same materials as the item being installed.
- Provide a cabinet 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.
- Install a Flasher Cabinet Assembly to operate overhead or shoulder mounted flashers that are powered with electricity.

1.3.2 Mounting/ Foundation

Mount the Cabinet as shown in the Standards Drawings.

1.3.3 Grounding-

- GROUNDING AND SURGE/LIGHTNING PROTECTION SHALL BE PROVIDED in every Flasher Cabinet Assembly (unless specifically forbidden by the Manufacturer).
- The Protector shall be Telephone Company grade, and be conformable with the Terminal Block
- Ground the cable shield.
- Run a No. 6 AWG bare stranded copper Ground Wire continuously from the Cabinet to the ground rod at the pole base. Where design requires, drive a new ground rod; and install a ground wire from the Cabinet to the ground rod.

1.3.4 Electrical Wiring

- Connect electrical cables to the terminals in accordance with the signal equipment Manufacturer recommendations.

1.4 Measurement

- Furnishing and/or Installing Flasher Cabinet Assembly, 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.

1.5 Payment

6845655	FURNISH & INSTALL FLASHER CABINET ASSEMBLY	EA
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Supplemental Technical Specification for Solar Powered Flasher Assembly

SCDOT Designation: 688.9

1.1 Description

This work shall consist of installing and/or furnishing a Solar Powered Flasher Assembly and performing all related wiring necessary, in accordance with these Specifications and the Standard Drawings.

1.2 Materials

Acceptable materials can be found on the current SCDOT Qualified Products List http://info.scdot.org/Construction_D/sitePages/qualifiedProducts3.aspx.

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Solar Powered Flasher Assembly.
- The Contractor shall furnish the ENGINEER with any warranties on materials provided by the Manufacturer or Vendor as normal trade practice, including a minimum 5-year warranty for the LED modules.
- The types of Solar Flasher Assembly is listed below:
 - 24/7 Single Solar 24 Hour Flashing Beacon
 - 24/7 Single Compact Solar 24 Hour Flashing Beacon
 - Dual 24 Hour Solar Powered Flashing Beacon
 - Dual Solar Powered School Flashing Beacon
 - Dual Compact Solar School Zone Flasher

1.3.2 Installation

- Install the entire assembly, including solar engine, signal housing and LED modules with all necessary hardware for mounting to one of the following pole types:
 - Pedestrian Pole
 - Side-of-pole arm
- If the sign is larger than 36 inches, install the assembly using two square perforated posts.
- Install Pedestrian Pole in accordance with 682.4 Pedestrian Pole and Base and the Standard Drawings.
- The entire assembly shall mount at one point. Separate mounting for the signal head or any other component shall not be required.

1.4 Measurement

Furnishing and Installing a Solar Powered Flasher Assembly, shall be measured by EACH, erected and placed as shown on the Plans, which shall include all electrical connections and all required incidental hardware and all necessary bases and foundations for poles.

Separate pay items for Pedestrian Poles are in accordance with 682.4 Pedestrian Pole and Base.

1.5 Payment

6865700	FURNISH & INSTALL SOLAR POWERED FLASHER ASSEMBLY - SINGLE BEACON	EA
6865701	FURNISH & INSTALL SOLAR POWERED FLASHER ASSEMBLY - DUAL BEACON	EA
6865702	FURNISH & INSTALL SOLAR POWERED FLASHER ASSEMBLY	EA

Supplemental Technical Specification for Working Crew with Equipment

SCDOT Designation: 689.1

1.1 Description

This item shall consist of performing work for the SCDOT, on a per hour bases for equipment and labor. This will include the contractor furnishing a crew of four persons, one bucket truck, one line truck and one foreman's vehicle to be worked at the line item price for working crew with equipment. The crew will need to be able to perform duties in the field of traffic signal installation and revisions. This item will be used for emergency calls and unforeseen work which cannot be predicted and there is no pay for. All work under this item, shall be approved by the ENGINEER, prior to engaging in any work where this item may be used. The ENGINEER reserves the right to refuse or engage this item. While engaged in this line item, there shall be no other line engaged by the contractor. The ENGINEER reserves the right to engage Primary Traffic Control while working under this line item. Engaging in any other line items in this contract while working under this line item will need the approval of the ENGINEER.

1.2 Construction

All work performed under this item shall have written approval from the ENGINEER before engaging in any work under this item. This item is to be used when there are unforeseen problems such as wet holes, borrowing roadways, rock holes and any other deemed problems or emergencies. In case of an emergency, the ENGINEER will call the CONTRACTOR in line for assistance with the installation or maintenance of an intersection, in this case both parties must agree on engaging this item. The ENGINEER will issue a work order and grant permission in writing to engage in this item.

1.3 Measurement

Working Crew With Equipment will be measured per HOUR.

1.4 Payment

Working Crew With Equipment accepted and measured as provided above, will be paid at the contract unit price bid for:

6887990	WORKING CREW WITH EQUIPMENT	HR
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Payment for working crew with equipment will be made per work order for the total hours worked on that work order. If the work order begins after the normal workday or on the weekend, time can be

charged at a rate of 1 ½ times pay per hour. This extra pay rate must be agreed on between the contractor and the ENGINEER prior to beginning work.

Pay Item Notes

This specification is not limited to these pay items. Other pay items may be applicable.

Supplemental Technical Specification for Traffic Signal System Training

SCDOT Designation: 689.3

1.1 Description

This work consists of providing Traffic Signal System Training.

1.2 Materials

1.2.1 General

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 all training. The instructors shall be employees of the manufacturer(s) of the traffic signal system components, or approved equal.

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 **DEPARTMENT**. 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 **DEPARTMENT** shall provide a listing of the expected trainees for each training session once 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 **DEPARTMENT** before permission to begin training is given.

1.2.2 Training Program Subjects

The **CONTRACTOR** shall provide training on the subjects listed in the special provisions. 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.

1.2.3 Acceptance of Training

Within 7 calendar days of the completion of each training class, the **DEPARTMENT** 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:

- Thoroughness and completeness of instructional coverage of the training program subject;
- Thoroughness and appropriateness of the training program subject materials, including class demonstration and audio/visual aids, to the instructional coverage; and,
- 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 **DEPARTMENT** shall provide information on which training classes are not acceptable and specify 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.

1.3 Measurement

This item shall be measured and paid on an HOURLY rate.

1.4 Payment

Training shall be paid for at the Contract price bid for the item established for:

6886020	TRAINING BEING SIGNAL RELATED SYSTEM TRAINING	HR
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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.

Pay Item Notes

This specification is not limited to these pay items. Other pay items may be applicable.

Supplemental Technical Specification for

Steel Pole with Mast-Arm

SCDOT Designation: 690.1

1.1 Description

This work shall consist of designing (foundations, lengths of arms, size of support arms), furnishing 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 designed and 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.**

1.2 Materials

Material Specifications are located at

http://www.scdot.org/doing/technicalPDFs/publicationsManuals/trafficEngineering/TrafficSignal_MaterialSpecs.pdf .

1.3 Construction

1.3.1 General

- The requirements detailed in this specification cover any other pay item not listed in Payment but pertaining to Mast Arms.
- The CONTRACTOR shall furnish the Engineer with all warranties on equipment and material offered by the Manufacturer as normal trade practice.
- Repair poles, which have been scratched or abraded so that bare metal is exposed, to the satisfaction of the Engineer. Repair holes drilled in poles or Mast-Arms
- Use hardware or components made of a non-corrosive material, or be of the same material as the item being installed.
- Install signal head using rigid signal head mount brackets. 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.
- Where required by the Plans, install signs using a rust proof mounting bracket.
- Powdercoating Color and type will be specified on the plans or in the Special Provisions.
- Decorative options will be specified on the plans or in the Special Provisions.
- Luminaires generally require a taller pole, per Standard Drawing or as noted in Special Provisions or Signal Plans.
- Luminaire to be furnished and/or installed must be provided by the same manufacturer as the mast arm, unless noted otherwise. Luminaire design and/or color should match mast arm design and/or color unless noted otherwise in Special Provisions or on Plans.
- Luminaires are metered separately from traffic signal, unless noted otherwise on the plans or in the special provisions.

1.3.2 Location

- Install the pole in the general location shown on the Plans.
- Coordinate with the Engineer to stake the field location of the pole, considering the property lines, underground utilities, and overhead clearances.
- ENGINEER will approve staked locations, however contractor is responsible for locating utilities.
- If utility conflicts are discovered, relocate pole in coordination with the Engineer's approval.

- The pole location may have to be moved based on unmarked utilities.
- The design of the mast arm is based on the location, length and soil type. Contractor shall not order mast arm poles until final pole location is determined free of utilities and is approved by the Engineer.
- Provide soil boring at each signal location to the satisfaction of the Engineer of Record designing the mast arm assembly and foundation. A minimum of one soil boring per signal to a 15' depth is required.

1.3.3 Foundation

- Contractor to provide foundation design (see 1.3.9), including depth and diameter of foundation, reinforcing cage design, strength of concrete;
- Drill a hole, as indicated in the foundation design.
- The hole shall be augured (earth-auger), and the concrete poured in UN-disturbed earth.
- Ensure the hole is a uniform diameter, and cleanly augured.
- The foundation shall be constructed with a circular reinforcing cage (**either tied together, or tack welded**) installed, in accordance with foundation design.
- Steel reinforcement shall conform to the requirements of DOT STANDARD SPECIFICATIONS, Section 703.2.1. The bars shall be of the size and type shown on the foundation design.
- The finished square surface above ground shall be as shown on the Standard Drawings.
- It may be necessary to use a jack-hammer in BED-ROCK; it may be necessary to use a heavy walled CAISSON to line the hole and to pump it dry in high water table areas or areas where springs are encountered. These materials, tools and additional labor are incidental to the project.
- 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.
- Mix, place, pour and test the concrete in accordance with SCDOT Standard Specifications, Sections 701, 702, 703, and 704.
- Use design concrete strength, minimum of CLASS 5000 for the foundation. Place the concrete in one continuous pour with vibration.
- Set the Anchor Bolts using pre-formed templates (wood or metal), to provide a "bolt-circle" in accordance with the Standard Drawings or with recommendations of the pole Manufacturer. Leave the templates in place for 2 days (48 hours).
- Capp conduit elbows at both ends, and secure in place in the excavated hole before pouring any concrete.
- Each foundation shall have a minimum of 1-3", 3-2" and 2-1" conduits placed in accordance with the Standard Drawings. Provide additional conduits if shown on the plans. These conduits are incidental to the work.
- Terminate all conduit provided in foundation in a 13"X24"X18"splice box; the splice box shall be installed in accordance with 680.2 Splice Boxes / Junction Boxes. The splice box shall be paid separately.
- Ensure all conduit elbows extend beyond the side of the finished foundation by a minimum of 12 inches, in the direction of, and at a depth matching the incoming conduit. Where a conduit elbow is placed for future use, scribe an "X" in the foundation to indicate the side where such conduit enters. Ensure the conduit protrudes a minimum of 6 inches above the top of the finished concrete foundation.

1.3.4 Grounding

- Furnish and install ground rods and grounding wire with each foundation.
- Configure the ground rod with the foundation, as shown on the Standard Drawings.
- Use grounding clamps of brass or bronze to secure the grounding wire to the ground rod.
- Use a continuous ground wire to bond all metal parts together--pole ground stud; pedestal pole nut; pole-mounted controller cabinet ground; metal conduits; etc.

1.3.5 Anchor Bolts

- Provide hooked anchor bolts at least 90 inches long with each steel pole with mast arms.

- Thread and hot dip galvanize the top 12 inches of the anchor bolt.
- Provide two hot dipped galvanized nuts and two washers per anchor bolt.

1.3.6 Adapter Plate

- Provide adapter plate with each mast arm that has a different anchor bolt pattern from SCDOT's standard steel pole pattern.
- **Note: Adapter plate(s), 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.**
- 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.
- 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.
- Adapter plate(s), bolt, and nut selection and design shall be stamped and sealed by a licensed South Carolina Professional Engineer.
- Provide a **BURLAP** bag containing the adapter plate nuts, bolts, and washers inside each steel pole with mast arms.
- Place the adapter plate, if required, between the leveling nuts and the steel pole with mast arms base.

1.3.7 Installation

- Do not place the mast arm pole on the foundation for a minimum of 2 days (48 hours after individual pour)
- Do not place a load on the mast arm poles for a minimum of 7 days (168 hours after individual pour) or as otherwise directed by the ENGINEER.
- Each Pole shall be raked away from the line of the Mast-Arm pull, by adjusting the nuts on the anchor bolts.
- When final load is applied, there shall be an essentially vertical appearance as determined by the Engineer.
- Provide 22' minimum vertical clearance between the bottom of the overhead traffic signal mast arm and the pavement and shoulders, unless otherwise shown on the plans.
- Restore the site to prime condition after the pole installation, back filling the area surrounding the pole with topsoil, raking it level and seeding. If the area is sloped, then use landscape turf.

1.3.8 Sidewalk/Island Installation

- When installing the pole in a sidewalk, cleanly cut out the entire "square" of the sidewalk and install the foundation as indicated above.
- Replace the sidewalk using expansion joint material to separate different "pours" and old/new concrete. This work is incidental, unless an item has been established for CONCRETE PATCH or for SIDEWALK.
- In concrete islands, saw-cut out a square opening 4 feet x 4 feet for the pole base and repair as stated above.
- When installed in SIDEWALKS or CONCRETE ISLANDS, contour the entire area and hand-finish to produce a neat visual line. Sharp edges or pedestrian hazards shall not be allowed.

1.3.9 Acceptance

- Acceptance of each pole shall include foundation strength testing plus visual inspection by the ENGINEER.
- The visual inspection shall be made of the pole, overhead cables, and grounding.
- The complete installation shall be structurally sound, and the final pole placement shall be vertical, or raked as specified.

- Contractor shall replace any poles NOT meeting this inspection, without further cost to the project.

1.3.10 Design Criteria

AASHTO Standards

- Ensure the Mast-Arm traffic signal Pole is designed to 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), latest edition.
- Design all components of the Mast-Arm Pole assemblies to include and to address the following:
 - Mast Arm Length
 - Soil type
 - Design Life – minimum 25-year mean recurrence interval
 - Basic wind speed in accordance with AASHTO Wind Speed map (latest edition)
 - Ice loading
 - Fatigue category II (2)
 - Natural wind gust pressure loads
 - Truck-induced gust pressure loads
 - Mast arm loading as follows in 1.10.2.

Minimum Loading Assumptions

- For design, minimum loading assume there is a 4-section polycarbonate, rigidly mounted signal head with backplate centered per lane including auxiliary lanes, an 24" x 8' illuminated street name sign on each arm, and additional 24" x 36" signs adjacent to each signal head. See plans to determine if additional loading is required. Design mast arms for the most stringent loading.

Design And Drawings

- 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.
- The CONTRACTOR SHALL FURNISH a concrete foundation design details and calculations adequate for local soil type and steel pole with mast arm loading.
- Mast arm loading shall be the greater of the Minimum Loading Assumptions or the loading shown on the Plans.
- The design and calculations shall be stamped and sealed by a licensed South Carolina Professional Engineer.
- **Provide CATALOG CUTS ARE REQUIRED FOR REVIEW AND APPROVAL PRIOR TO FABRICATION.**

Miscellaneous Items

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

- 4" x 6" minimum reinforced handhole,
- ½" 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

1.4 Measurement

The following pay items will be measured by Each (EA) erected in place as shown on the plans:

- Design shall include all necessary services to completely design mast arm installation, including necessary geotechnical work, utility research, foundation design, mast arm upright and arm structural design and determining length of mast arms.
- Furnish includes delivery costs and all necessary components necessary to provide and install a fully functional mast arm, including all hardware Adapter Plates (if applicable), Anchor Bolts, Nut Covers, Pole Cap, reinforcing steel, ground rod, ground wire, and all miscellaneous hardware as required.
- Install pay items including foundation include all materials and work necessary to completely install mast arm structure, including rebar, concrete, conduit, and forms.
- Install pay item without foundation includes all work necessary to install mast arm on existing foundation.
- Powdercoating pay items include providing a color option for mast arms, either over the base mast arm material or over the galvanized mast arm material
- Decorative option per mast arm includes providing decorative features such as ornamental pole bases (skirts), fluted options, banner arms or curved options, in accordance with the special provisions or plans.
- Luminaire option for mast arm includes the additional cost for a taller pole (27'), if luminaire is to be mounted above the signal heads.
- Furnish and install mounting assembly pay items include installing the mounting hardware for signs and for signal heads on the mast arm, including all necessary hardware.
- Furnish and install Luminaire includes all necessary materials, equipment and labor for full operational luminaire assembly, including electrical cable, conduit and meter pan if metered separately from traffic signal.
- Pay items for mast arms designating the height and length of the mast arms will only be used when the Engineer has designed full mast arm plans; payment and will be paid for at the contract unit price Each (EA), and include all materials, hardware, manpower and equipment to fully install a functional mast arm assembly.

The following pay item will be measured by cubic yard (CY):

- Install Foundation for Mast Arm includes all materials and work necessary to completely install mast arm foundation, including rebar, concrete, conduit, and forms.

1.5 Payment

6888179	DESIGN, FURNISH & INSTALL STEEL POLE WITH MAST ARM INCLUDING FOUNDATION	EA
6888172	DESIGN, FURNISH & INSTALL STEEL POLE WITH MAST ARM WITHOUT FOUNDATION	EA
6888177	DESIGN, FURNISH & INSTALL STEEL POLE WITH TWIN MAST ARMS INCLUDING FOUNDATION	EA
6888178	DESIGN, FURNISH & INSTALL STEEL POLE WITH TWIN MAST ARMS WITHOUT FOUNDATION	EA
6888166	POWDERCOATING PER MAST ARM OVER BASE	EA
6888167	POWDERCOATING PER MAST ARM OVER GALVANIZED	EA
6888168	DECORATIVE OPTION PER MAST ARM	EA
6888169	LUMINAIRE OPTION FOR MAST ARM - TO ACCOUNT FOR TALLER POLE	EA
6513020	FURNISH & INSTALL MOUNTING ASSEMBLY FOR FLAT SHEET SIGN ERCTD ON MAST ARM	EA
6865831	FURNISH & INSTALL VEHICLE TRAFFIC SIGNAL HEAD MOUNTING ASSEMBLY FOR MAST ARM	EA
6888164	FURNISH & INSTALL DUAL LUMINAIRE INCLUDING LUMINAIRE ARMS AND ALL ASSOCIATED HARDWARE	EA
6888165	FURNISH & INSTALL SINGLE LUMINAIRE INCLUDING LUMINAIRE ARMS AND ALL ASSOCIATED HARDWARE	EA
6888174	INSTALL FOUNDATION FOR MAST ARM INCLUDING CONCRETE AND REBAR	CY

	FURNISH & INSTALL ___' STEEL POLE WITH ___' MAST ARM INCLUDING FOUNDATION	EA
	FURNISH & INSTALL ___' STEEL POLE WITH TWIN MAST ARMS (___'X___)AT ___ DEG. INCLUDING FOUNDATION	EA

Supplemental Technical Specification for

Short-Range Radio Device Detector System

SCDOT Designation: 699.1

1.1 Description

This work shall consist of furnishing and/or installing a Short- Range Radio Device Detector System to detect vehicles on a roadway by using battery- powered magnetometer- type sensors that communicate their detection data by radio to a roadside communications hub before the data is relayed to a local traffic controller and, optionally, a central software system or a data server as may be desired.

The Short- Range Radio Device Detection System shall be capable of monitoring and measuring vehicular and pedestrian movement by identifying and comparing unique Bluetooth (BT) MAC (Media Access Control) addresses associated with Short- Range Radio enabled electronic devices. The system can be used to collect high quality, high- density travel times by sampling a portion of actual travel activity from the traffic stream of a predetermined route. The BT MAC address received by a sequence of two or more Short- Range Radio Device receivers shall be matched and used to develop a sample of travel time for that particular segment of the roadway, based on the relative detection times recorded by the adjacent units. The BT MAC address being detected shall be both discoverable and non-discoverable.

1.2 Materials

The Short- Range Radio enabled device (sensor) shall be an anonymous Short- Range Radio Device BT MAC address, which is a hardware identifier for the manufacturer and specific electronic device type. BT MAC addresses are not associated with any specific user account or any specific vehicle. The BT MAC address shall not be linked to a specific person through any type central database, but is assigned by the Short- Range Radio Device electronic chip manufacturer and shall not be tracked through the sales chain. Privacy concerns typically associated with alternative probe systems shall be eliminated.

A. Requirements (Type A, Type B, and Type C)

The Short- Range Radio Device Detection System shall be connected to, and work in conjunction with the support data processing system, located in a designated server. All The Short- Range Radio Device Detection units shall adhere to the following requirements:

- } Short- Range Radio Device: Class 1 Transceiver with 4 dB to 8 dB Omni Directional Antenna
- } Environmental: - 30°C to +65°C, 5 – 90% humidity
- } Connectivity: IP/Ethernet 10/100 Base- T (minimum)
- } I/O ports: minimum one (1) RJ45 Ethernet port

a. Short- Range Radio Device Detection System, Type A

Provide a Short- Range Radio Device Detection System that can be installed in a typical signal or ITS cabinet. The unit shall be enclosed in its own housing and sit on a shelf within the cabinet. Utilize a conduit, as shown on the plans, for routing the antenna cable, and attach the antenna at the location shown on the plans. The power for the Short- Range Radio Device Detection System, Type A unit shall come from typical cabinet power (110 VAC) receptacles or terminal block. Supply all wiring for the Short- Range Radio Device Detection System Type A unit. Should the unit require a POE adapter or transformer to VDC, submit the adapter or transformer to the Department for review. The Contractor shall supply all surge protection devices for the external POE adapter or transformer.

b. Short- Range Radio Device Detection System, Type B

Provide a Short- Range Radio Device Detection System that is self enclosed in a NEMA 4X enclosure that can be mounted to a pole, mast arm or cabinet structure. The voltage input shall be between 6 and 30 VDC, or be able to connect to 110 VAC with appropriate transformers and adapters, as determined by the Department. The Short- Range Radio Device Detection System Type B unit shall be wired to a cabinet or approved communication/power source, as shown on the plans. The unit shall not reside within the cabinet. Provide all grounding, wiring, adapters, transformers, and surge protection devices needed to support the Short- Range Radio Device Detection System Type B unit, as installed.

c. Short- Range Radio Device Detection System, Type C

Provide a Short- Range Radio Device Detection System that is self enclosed in a NEMA 4X enclosure that can be mounted to a pole, mast arm or cabinet structure. Provide a Solar Power Array, which includes the solar panel, charging unit and batteries necessary for solar power. The Short- Range Radio Device Detection System Type C unit shall also include a GSM cellular modem with antennas, or approved equivalent. This Short- Range Radio Device Detection System type shall be a completely wireless installation. Provide all grounding, wiring, adapters, transformers, and surge protection devices needed to support the Short- Range Radio Device Detection System Type C unit, as installed.

d. Short- Range Radio Device Detection System Support Data System Software and Database

Provide a Support Data System software package, including all necessary database 3rd party software required in order for the software to run as intended in support and conjunction of the Short- Range Radio Device sensor system. The software shall be installed on a server designated by the Department. It is the Contractor's responsibility to populate and configure the database for each field Short- Range Radio Device Detection System, and to test the accuracy of the data. The data shall be in an XML format compatible with the Department's central software. The software shall also display a real time chart or graph showing calculated travel time and speeds of the sampled vehicles and BT MAC address counts. The Short- Range Radio Device Detection System support software is required for all new Short- Range Radio Device Detection System installations, but shall not be required for additional Short- Range Radio Device Detection System sensor installations on an existing network.

B. **Functional Requirements for the Short- Range Radio Device Detection System**

The sensor shall be capable of delivering data from both an Ethernet connection and a wireless cellular modem. The Short- Range Radio Device Detection sensor working in conjunction with the network's support data processing system must deliver real- time speed and travel time information in XML format to the central software system for routes where the sensors are deployed. The system shall be able to add multiple pairs of Short- Range Radio Device Detection sensors to form a network of manageable travel routes. Each route will display the data for the first and last sensor in addition to the travel- time and speed information for that segment. The Short- Range Radio Device Detection sensor shall be able to detect, at a minimum, within a radius of 300 feet when mounted on a pole or mast arm. The data processing shall be able to filter and 'throw out' BT MAC addresses that do not supply accurate information when compared to other device time stamps of the segment between two Short- Range Radio Detection devices. The data shall be smoothed, and be able to process median and mean average speeds. The following data shall be able to be compared and filtered, as needed, to deliver the most accurate information:

1. Pedestrians
2. Oversize Vehicles
3. Mass Transit (i.e. nearby trains or buses)

The Short- Range Radio Device Detection System equipment shall contain advanced features designed to allow the unit to operate efficiently in a remote environment. Diagnostic and configuration information shall be able to be viewed remotely, such that the health and operating status of the sensor is known. The system shall be designed to be able to automatically or remotely "reboot" if a condition is detected that requires such action.

1.3 Construction

Installation

- A. Installation shall be in accordance with manufacturer's instructions.

Testing

- A. Develop and submit plans for post- installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements .
- B. Provide the Engineer with the appropriate XML data interface, as necessary, for testing of the travel time accuracy and integration into the central software.
 - 1. Post- installation test procedures: Utilize the following test procedures after the Short- Range Radio Device Detection System has been installed in its entirety as shown on the Plans. Commence no post- installation testing until all Short- Range Radio Device Detection sensors systems in the project have been configured, calibrated and programmed to communicate on the SCDOT network to the support data system software. At a minimum, provide the following on the test plan to be submitted and approved by the Engineer:
 - a. Inspect all Short- Range Radio Device Detection System field components to ensure proper installation and cable termination.
 - b. Inspect the quality and tightness of ground and surge protector connections.
 - c. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.
 - d. Verify that the installation of cables and connections between all Short- Range Radio Device units, antennas and field cabinets and/or components are as specified in the Plans
 - e. Demonstrate that each Short- Range Radio Device unit is fully operational and gathering the required data types at the specified and necessary interval.

1.4 Measurement

Furnishing and/or Installing Components of a Short- Range Radio Device Detector System shall be measured as EACH unit and includes all hardware and cables necessary for installation and operation, and license.

1.5 Payment

6990000	Short-Range Radio Device Detection System Support Data System Software and Database	LS
6990010	Short-Range Radio Device Detector System Type A- w/ License	EA
6990011	Short-Range Radio Device Detector System Type B - w/ License	EA
6990012	Short-Range Radio Device Detector System Type C - w/ License	EA