

## ITS ELEMENTS INSTALLATION (SCDOA)

### PROJECT DESCRIPTION

- A.
1. Scope: South Carolina Department of Administration (SCDOA) Fiber System – The Project includes the installation of a Fiber System along I-26, I-20, I-126, and associated frontage and crossing roads, throughout the limits of the project. The CONTRACTOR will furnish and install a SM fiber optic cable (FOC) in 2-inch conduits, fiber optic cable splicing and terminations, fiber optic cable testing, service boxes, and all miscellaneous hardware required to make an operational system per the specifications, as listed, complete to the satisfaction of the DEPARTMENT. The CONTRACTOR shall also provide as-built plans to include: directional bore logs, conduit offsets every 500', all service and pull boxes, and mid span and reel end splices (three complete sets). An electronic copy of all GPS data will be turned in at the same time as as-built plans. Allocation drawing and Bentley Fiber data entry will be furnished by the DEPARTMENT as part of the integration.
  2. The new SMFOC (Fiber Optic Cable) shall be spliced in an existing service box (I-126 WB approximate Sta. 4388+00 Rt) installed in CCR Phase 1, to the existing SMFOC, and at an existing service box located along St. Andrews Road at approximate Sta. 44+15 Rt. to the existing SMFOC. The new SMFOC shall also be spliced at an existing service box along Bush River Road Ramp F at approximate Sta. 4113+25 Lt to the existing SMFOC. The termination shall be a reel end splice at all locations.
  3. Prior to commencing construction, the DEPARTMENT will remove all existing ITS cameras and cabinets only. **THIS DOES NOT INCLUDE** camera poles, cabinet bases, conduit, fiber, electric services, dynamic message signs and structures from the project.  
  
The CONTRACTOR shall remove and dispose or salvage all impacted ITS infrastructure as described in the RFP.
  4. Training: Per Section 6 of FURNISH AND INSTALL FIBER OPTIC CABLE, the CONTRACTOR shall furnish training as defined.
  5. Service boxes: Service boxes shall be installed as shown on the plans and as indicated on either end of the embedded ITS conduit as described in the Technical Provisions (TPs), though not to exceed a maximum of 2450 foot spacing or as indicated on plans. Service boxes shall also be installed as needed for fiber optic splicing and cable management. Each service box shall have the SCDOT Fiber Optics logo cast in the lids. Each service shall have a passive marker ball operating at 101.4 KHZ, orange in color. In cases where a service box is to be used for electrical cabling, the lids shall have the SCDOT Electrical logo cast and shall have a red passive marker ball operating at 169.8KHZ installed. At each service box location, a PNA type marker post shall be installed (orange top for fiber optic and red top for electrical). GPS location shall be determined for all boxes installed and shown on as-built plans.
  6. The Fiber Optic Backbone: The fiber optic backbone shall be fiber single-mode cable with ten (10) buffer tubes with 12 fibers each. It shall be installed in a 2" conduit where shown. Splicing of the cable shall only be allowed at specified locations to be approved by SCDOA. Buried backbone cable shall have orange marking tape above it and above ground cable markers at every service box. GPS locations shall be determined for all mid spans/reel end splices and shown on as-built plans. No subsurface investigation has been done. It shall be the CONTRACTOR's responsibility to verify that the cable can be buried at specified depth using pre-plowing or other methods to be approved by SCDOA. **New SM fiber optic Backbone cable installed along I-26 shall be a Prysmian cable or approved equal.**
- B.

### GENERAL PROVISIONS

1. All work under this Contract shall be performed under the latest editions of following standards:

THE SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION, "STANDARD SPECIFICATIONS FOR HIGHWAYS CONSTRUCTION", Latest Edition;

These SPECIAL PROVISIONS;

The "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES", "MUTCD - 2009 Edition";

The "INTELLIGENT TRANSPORTATION SYSTEM SPECIFICATIONS";

The "NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)";

The "NATIONAL ELECTRICAL SAFETY COUNCIL (NESC)";

The "ELECTRONIC INDUSTRIES ASSOCIATION (EIA);

The "NATIONAL ELECTRIC CODE (NEC)";

The "United States Department of Agriculture Rural Utility Service (RUS)";

The "AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM);

The "AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)"; and

Any other standards, codes and ordinances that may apply.

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

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES:

"The CONTRACTOR is hereby advised that the DEPARTMENT has adopted the MUTCD 2009 – Manual on Uniform Traffic Control Devices for use on all projects. All references to the South Carolina Manual on Uniform Traffic Control Devices (SCMUTCD) are hereby revised to read "MUTCD – 2009 Edition".

**C. CODES, LICENSES, & ABILITIES**

1. All work shall be done in a workmanlike manner to meet the highest industry standards, all in accordance with the requirements of the latest editions of the National Electric Code (NEC), National Electrical Safety Council (NESC), the Illuminating Engineering Society (IES), American National Standards Institute (ANSI), National Electrical Manufacturer's Association (NEMA), and the regulations and standards of the local power company.
2. The following supplements Section 102.1. The contracting firm responsible for the performance of the work covered by these SPECIAL PROVISIONS, **must be licensed as a General Contractor with a Classification of Public Electrical Utility (2U) by the SC Licensing Board for Contractors, and possess all other sub-classifications and licensing as required by the SC LLR.** Documentation of properly trained personnel for exothermic welding is required for all personnel performing exothermic welding. A copy of the documentation for exothermic welding shall be submitted to the DEPARTMENT.
3. Further, at least one 'ON-SITE' field supervisor shall have LEVEL II or higher, Fiber Optics for ITS Certification by the International Municipal Signal Association (IMSA). Photocopies of the license and certificate shall be submitted before work commences. CONTRACTOR personnel performing Fiber optic testing, splicing, terminating, and/or troubleshooting shall have Level II IMSA Fiber Optics for ITS or ETA FOI certification. The CONTRACTOR shall retain employee(s) holding the appropriate licenses to conduct this type of work for the duration of the project; and the employee(s) shall be present ***DAILY and*** at the ***FINAL INSPECTION***. The CONTRACTOR shall submit the names and copies of these licenses and certifications to SCDOT prior to contract award.
4. The CONTRACTOR shall employ persons capable of installing all the components of this project as described in the Plans and Specifications.

## **SUPPLEMENTAL SPECIFICATIONS**

The ITS components shall be constructed in accordance with the detailed "SUPPLEMENTAL SPECIFICATIONS, and the plan details, which by reference are made a part of these SPECIAL PROVISIONS. These documents may be obtained from the SCDOT, Director of Traffic Engineering, Advanced Systems Coordinator, P.O. Box 191, Columbia, SC 29202-0191.

### **SPECIAL INSTRUCTIONS TO CONTRACTOR**

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1. This is a "TURN-KEY" project. The plans will be field reviewed with the CONTRACTOR and SCDOT/SCDOA engineers before installation begins. Any field supervisor for the CONTRACTOR must be at this review. The CONTRACTOR must devise/refine the final details, working within the Supplemental Specifications, the Design Details, the Standards, and with the ENGINEER. The ENGINEER must approve the Plans as submitted by the CONTRACTOR before construction begins.

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2. At project completion, all ITS components shall be complete and operational to the satisfaction of the ENGINEER.
3. The CONTRACTOR shall furnish and install conduit, service boxes, and stainless steel pull boxes where needed or as shown on the plans.
4. The CONTRACTOR SHALL FURNISH AND INSTALL ALL MATERIALS including fiber optic cables, conduit, miscellaneous fittings, service boxes, ground rods, fiber optic Siecor or equivalent interconnect centers, and all other needed materials.
5. Submittal Data Requirements: Work cannot begin on any part of the project until the RFC Plans are approved by the DEPARTMENT. The submittal data shall be furnished to the DEPARTMENT Project Engineer. Submittal data shall include complete technical and performance specifications on all hardware, materials, and installation cabling to be performed on the ITS project. Each package of submittal data shall be neatly organized and separated by hardware item and shall contain an index of all submittal data documents included in the package. The index shall name each submittal data document, what ITS system component the document is submitted for, and the specific manufacturer model, part and revision number of the subject hardware or software item exactly as the item is proposed to be provided. Any submittal data document or documentary item that is not listed in the index shall not be accepted for review. Each package of submittal data shall address all of the components and materials necessary for a complete ITS system as spelled out in the specifications; separate submissions for individual ITS system components and materials are not permissible. Typical submittal data which is required for all ITS system components shall include, but is not limited to, manufacturer's specifications, operating/maintenance, troubleshooting manuals, materials lists and assembly drawings for the components used on this project, acceptance testing procedures, and detailed warranty and guarantee information for each component.
6. CONTRACTOR shall be responsible for new electrical and fiber optic cable locates during project. CONTRACTOR shall be responsible for locating PUPS tickets for all new electrical and fiber optic cable locates within the project area throughout the duration of the project.
7. CONTRACTOR is responsible for preventive maintenance on all new components within the project. Preventive maintenance shall start upon notice to proceed. Preventive maintenance consists of weed and grass control, rodent control and repairs as needed. Preventive maintenance is to be performed every three months during project. New components installed shall be serviced every three months after installation until completion of project.
8. SUBMISSION OF REQUIRED DESIGN INFORMATION AND DESIGN DRAWINGS: It is essential that the signing contractor make all required design submissions within 90 days following award of this contract, except as follows:

Section 9.103 of Signing Specifications is amended to also require that design drawings for Overhead Sign Structures and the details of footings be submitted within 90 (ninety) calendar days following award of the contract.

Section 9.104 of the DEPARTMENT's SPECIFICATIONS FOR SIGNING EXPRESSWAYS AND FREEWAYS is revised to require that the independent registered Professional Engineer who checks the designs for the overhead structures and footings be licensed by the State of South Carolina.

#### **OVERHEAD SIGN STRUCTURE DESIGN:**

Section 9.101 of the Signing Specification is amended to require stiffener plates between the base plate of all cantilever structures and the upright. The plates should be equally spaced about the base plate between the anchor bolt holes. All structures shall have at least six (6) anchor bolts per base plate. Also, the CONTRACTOR shall provide direct bolted connections of the sign to the structure sign hangers at the top and bottom of the signs. This shall be provided at all four corners of the sign. The top hole on each hanger shall be slotted to provide for adjustment.

Soil borings are not provided for the locations of the new Overhead Structures. The CONTRACTOR will be responsible for obtaining subsurface investigation data at the locations of the overhead structures shown in the plans for the purpose of overhead structure footing design. Special Note: Footings shall be designed using a maximum allowable toe pressure of 2000 pounds per square foot.

#### **ACCEPTANCE**

- F. This project requires a 30 (thirty) day burn-in period. All equipment shall operate satisfactorily for a period of 30 calendar days prior to final acceptance of the project. Any items deemed non-operational in that time period will cause the burn-in period to start over. The burn-in period shall not begin until all equipment is installed and operational. The burn-in period shall not begin until a punch list, generated by the final inspection, is complete.

G. **INSPECTION**

1. Resident Construction Engineer (RCE): During construction of the ITS portion of the Project, periodic Inspections will be made by the RCE and by the DEPARTMENT's ITS staff. The DEPARTMENT's RCE is the designated representative of the ENGINEER, for the purposes of this project.
2. Disputes: The CONTRACTOR is advised that in any dispute between the CONTRACTOR and the manufacturer, concerning the operation/maintainability/reparability of any piece of equipment, THE DECISION OF THE ENGINEER SHALL BE FINAL.

- H. 3. Faulty Equipment: The CONTRACTOR shall be responsible for the labor cost to remove and replace faulty equipment. The CONTRACTOR shall be responsible to have a replacement part in place no later than 24 hours from the reported failure of the equipment.

#### **MAINTENANCE OF TRAFFIC**

The CONTRACTOR shall maintain traffic throughout the length of this Project as required by the Manual on Uniform Traffic Control Devices and other applicable SCDOT Standards for traffic control. As part of the plans, the CONTRACTOR shall provide traffic control plans prior to beginning work. Any necessary lane closures will have to be approved by the ENGINEER two weeks prior closing the lane. Interstate lane closures shall be done only at night. Shoulder closers are required when work is performed within 30 feet of the travel way. This includes the parking of vehicles or equipment.

Should the CONTRACTOR believe a lane closure is necessary to perform the work specified herein, the CONTRACTOR shall submit to the ENGINEER a written request at least two (2) weeks in advance of the proposed closure. The request for lane closure shall include:

1. Date and times that the closure is required.

2. Reason for the closure, and why the work cannot be accomplished without the requested closure.
3. A plan showing the lane(s) to be closed, the extent of the closure, the work area, and the proposed signing and other traffic control devices to be installed by the CONTRACTOR for the maintenance and protection of traffic during the closure.
4. Date and time that the closure will cease and related signing and other traffic control devices will be removed and normal traffic control will be re-established.

The RCE shall review the request, and shall approve, reject, or identify modifications to the plan necessary for approval.

Training will be furnished as part of the Traffic Control bid item with no additional cost to the DEPARTMENT.

5. The CONTRACTOR will be required to furnish approved Supervisor and Advanced work zone traffic control training courses for up to ten (10) SCDOT employees, as part of Traffic Control. The DEPARTMENT reserves the right to allow others to attend training.
6. Training shall be scheduled on a date selected by ITS Field Operations Manager during the project (CONTRACTOR should note that this training may be required at the beginning of the project; however it must be conducted prior to Substantial completion of ITS infrastructure for this contract.)
7. Work zone training will be conducted in accordance with the below specifications by a recognized organization.

Approved Work Zone Traffic Control Training Providers:

The SCDOT recognizes the following organizations as acceptable providers of an advanced work zone traffic control training program, a "Flagger Training" course or the optional basic work zone traffic control training course:

8. American Traffic Safety Services Association (ATSSA)
9. Institute for Transportation Research and Education at North Carolina State University (ITRE)
10. Carolinas Association of General Contractors (AGC)
11. National Safety Council - South Carolina Chapter

These organizations provide work zone traffic control training in compliance with the MUTCD and reference requirements specific to SCDOT. Therefore, work zone traffic control training provided by entities other than those listed above are not considered comparable and shall be unacceptable.

- I. Specific course material for work zone traffic control training courses designated as "Basic", "Advanced", "Supervisor" or "Flagger" and any additional training courses not specified here is determined by the work zone traffic control training course provider and has undergone review and received acceptance by SCDOT. Also, the passing score for each training course is determined by the work zone traffic control provider.

## **MOBILIZATION**

Description: This item shall consist of performing preparatory operations, including moving personnel and equipment to the project site; paying bonds and insurance premiums, establishing CONTRACTOR'S offices, buildings and other facilities necessary for work on the project and for all other work and operations which must be performed or cost incurred prior to beginning work on the project.

Construction Requirements: All work performed in providing the facilities and services shall be done in a safe and workmanlike manner.

## FURNISH AND INSTALL CONDUIT

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

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### 1. MATERIALS: MATERIALS SHALL MEET THE REQUIREMENTS LISTED BELOW:

- a. STEEL CONDUIT: STEEL ELECTRICAL CONDUIT SHALL BE RIGID, HEAVY-WALL, GALVANIZED STEEL, MEETING THE REQUIREMENTS OF FEDERAL SPECIFICATION WW-C-581, AND AMERICAN STANDARDS ASSOCIATION SPECIFICATIONS USAS C-80.1-1966.
- b. PVC CONDUIT: PLASTIC CONDUIT SHALL BE SUNLIGHT RESISTANT POLYVINYL CHLORIDE (PVC), SCHEDULE 80, MEETING THE REQUIREMENTS OF NATIONAL ELECTRICAL MANUFACTURING ASSOCIATION (NEMA) SPECIFICATION TC-2 AND UNDERWRITER LABORATORY (UL) STANDARDS UL-514; AND/OR ASTM D-1784. FITTINGS SHALL MEET NEMA TC-3 AND UL-514. NO QUARTER SIZE CONDUIT SHALL BE USED. CONDUIT SIZES SHALL BE AS FOLLOWS: 1 INCH, 2 INCH, 3 INCH AND SO ON.
- c. HDPE ROLLED CONDUIT: UNDERGROUND FIBER SHALL BE INSTALLED IN ROLLED CONDUIT, PLOWED OR DIRECTIONAL BORED (TRENCH LESS) IN. EACH RUN SHALL HAVE ONE (1) CONDUIT INSTALLED. THIS CONDUIT SHALL BE A MINIMUM OF SCHEDULE 80 OR SDR 11 HDPE (HDPE SHALL BE ORANGE IN COLOR FOR FIBER OPTIC CABLE INSTALLATIONS AND RED IN COLOR FOR ELECTRICAL). IT SHALL BE BURIED AT A MINIMUM OF 36".
- d. FLEXIBLE WEATHER-TIGHT STEEL CONDUIT: WEATHER-TIGHT/LIQUID-TIGHT FLEXIBLE STEEL ELECTRICAL CONDUIT SHALL BE SINGLE STRIP, HELICALLY WOUND, INTERLOCKING GALVANIZED STEEL. IT SHALL BE MADE LIQUID-TIGHT BY AN EXTRUDED POLYVINYL CHLORIDE JACKET; AND SHALL MEET THE REQUIREMENTS OF UL-360.
- e. FITTINGS: ALL CONDUIT BODIES, 90 DEGREE BENDS, WEATHERHEADS, ELBOWS, NIPPLES, COUPLINGS, AND OTHER HARDWARE SHALL BE MADE OF THE SAME MATERIAL AND QUALITY AS THE CONDUIT RUN AND SHALL BE INCIDENTAL TO CONDUIT INSTALLATION. HDPE COUPLING SHALL BE HYDRAULICALLY PRESSED ON TYPE. HDPE COUPLINGS SHALL BE CARLON BARBED COUPLINGS BS2.375 OR APPROVED EQUAL. CATALOG CUTS ARE REQUIRED FOR HDPE COUPLINGS FOR APPROVAL.
- f. GROUND BUSHINGS: GROUNDING BUSHINGS SHALL BE THREADED, MADE OF MALLEABLE IRON, GALVANIZED STEEL, OR BRASS; AND SHALL HAVE AN INSULATING PLASTIC INSERT, AND LAY-IN LUGS TO HOLD NO. 6 AWG COPPER WIRE.
- g. PULLING LINE: THE PULLING LINE SHALL BE MULETAPE WP1250P OR DETECTABLE MULETAPE DT1250/4P, HAVING A MINIMUM STRENGTH OF 1250 LBS, WHICH SHALL BE PULLED INTO ALL UNDERGROUND CONDUIT RUNS, AND SHALL REMAIN THEREIN FOR FUTURE USE.
- h. WARNING TAPE: UNDERGROUND WARNING TAPE SHALL BE HEAVY DUTY B-720 POLYETHYLENE, 0.89 MM (3.5 MILS) THICK, BY 76 MM (3 INCHES) WIDE, WITH APWA COLOR ORANGE FOR FIBER AND RED FOR ELECTRIC LINES. THE TAPE SHALL BE PLACED ABOVE ALL TRENCHED CONDUIT RUNS, JUST BEFORE THE FINAL BACK-FILL.
- i. CONCRETE: CONCRETE USED FOR PATCHING PAVEMENT SHALL BE SCDOT STANDARD SPECIFICATION CLASS X ACCORDING TO SECTIONS 701, 702, 703, AND 704.
- j. BITUMINOUS ASPHALT: BITUMINOUS ASPHALT FOR PATCHING PAVEMENT SHALL BE SCDOT STANDARD SPECIFICATIONS, SECTION 403.
- k. MARKING WIRE: ALL UNDERGROUND CONDUITS CONTAINING FIBER OPTIC CABLE SHALL HAVE A FOUR (4) CONDUCTOR DETECTABLE MULETAPE TYPE DT1250/4P PULLED IN FOR FUTURE LOCATE SERVICES. THE DETECTABLE MULETAPE SHALL BE SPLICED THROUGH ALL JUNCTION

POINTS AND GROUNDED TO A RUS 13 5/8"X8' GROUND ROD IN SERVICE BOXES AND CONNECTED TO THE GROUND BUSS IN CABINETS.

**2. CONSTRUCTION METHODS:**

- a. General: Conduit shall be installed as either a riser, or be trenched, plowed or directional bored (trench less), or embedded in the barrier wall.
- b. Plans: All conduit shall be installed as trenched, plowed or riser unless specifically shown on the plans as or site determined by SCDOA as directional bored. Conduit off-set shall be performed every 500' and shown on as-built plans. Directional bore log indicating depth of conduit shall be shown on as-built plans.
- c. Depth: Unless shown otherwise, conduits shall be placed a minimum depth of thirty-six (36) inches below surface grade, when approved by the ENGINEER a min. of 24" cover when rock is encountered, rock being defined in section 203.2.1.7 of the Standard Specifications of Highway Construction Edition of 2007, and shall slope at a minimum rate of 150 mm (six inches), per 30 meters (100 ft.) of length, to a service box hole or drain. All conduit runs shall be cleaned and swabbed before cables are installed. In poles, cabinets, and buildings, duct-seal shall be used to effectively seal the opening.
- d. Direction: Changes in direction of conduit shall be accomplished by the use of standard bends, elbows, or by bending the steel conduit. Steel conduit, if bent, shall have a uniform radius that will fit the location and will have an angle of 45 degrees, 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.
- e. Fittings: Standard manufactured conduit bodies, condulets, elbows, nipples, tees, reducers, bends, couplings, expansion couplings, unions, etc., of the same materials and treatment as the straight conduit, shall be used as required throughout the conduit line. All fittings shall be tightly connected to the conduit. A solvent-weld cement shall be used for fitting connections with PVC conduit. Where steel conduit mates PVC, an adapter coupling shall be used and sealed waterproof. Where Metallic / Non-Metallic Flex mates PVC an approved adapter coupling shall be used. Where HDPE mates PVC a service box/pull box shall be installed.
- f. Cutting: Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where it is necessary to cut and thread steel conduit, no exposed threads will be permitted. All conduit fittings shall be free from burrs and rough places; and all cut conduits shall be reamed before fittings and cables are installed. All conduit runs ending in a junction box, hand box, or other approved junction point, shall be provided with a bushing to protect the cable from abrasion. Conduit being placed for future use shall be capped.
- g. Location: Where conduit passes under a curb, an 'X' shall be cut in the curb, over the conduit. Where there is no curb, a stake shall be driven in the ground at the end of the conduit to mark its location.
- h. Trenching (Non-Paved Surface): Trenches shall be excavated to such depth as necessary to provide (24" minimum in rock, rock being defined in section 203.2.1.7 of the Standard Specifications of Highway Construction Edition of 2007, when approved by the ENGINEER) 36 inches minimum cover over the conduit. Cinders, broken concrete, or other hard abrasive materials will not be permitted in the backfilling. The trench shall be free of such materials before the conduit is placed. CONTRACTOR shall supply approved back fill material as needed in such cases. No conduit shall be placed prior to inspection by the ENGINEER. Back-fill shall be compacted, and the surface restored.

- i. Trenching (In Paved Surface): Trenches across driveways or streets shall be cleanly saw cut about 150 mm (six inches) wide. The conduit shall be placed, and the backfill shall be compacted, and the patch shall be of like material and thickness as was removed. NO additional payment shall be made for the bituminous or concrete patching material unless a pay item has been established for such.
- j. Bored and Jack (Pushing): Where shown on the Plans as bored or jacked, certain steel conduit to be placed under existing roadways, driveways, sidewalks, or other paved surfaces, shall be bored and jacked. Such conduit shall be placed by jacking, boring, pushing, or other means approved by the ENGINEER, without cutting or removing pavement.
- k. Bored and Jack (Pulled): When the SCDOA Fiber design anticipates that high-accuracy directional boring techniques will be used, and two (2)- two (2) inch schedule 80 or SDR 11 HDPE conduits pulled back through the bore, then a pay item will be established for: SCHEDULE 80 PVC CONDUIT (trench less). The directional boring method shall be approved by the ENGINEER and shall in no way crumple or damage the conduit.
- l. Placed Before Pouring: Where shown on the Plans, PVC conduit, with flexible weather tight conduit, shall be placed in roadways or structures, prior to pouring the concrete. Typical usage would be a bridge deck. The conduit shall be firmly attached to the bottom reinforcement bar mat, or to the bottom wire-mat, using plastic tie-wraps every 0.60 meter (two feet). At expansion joints, 1.2-meter (four ft.) lengths (typical) of flexible weather-tight steel conduit shall be used to accommodate movement. These shall be installed to NEC standards for concrete structural installations and usage, including any recommended lubricants and sleeves. All conduit ends etc. shall be plugged to prevent concrete penetration. When used on a bridge, there will usually be service-box(es) near the centerline, and the conduit will terminate in service-boxes at each end.
- m. Restoration: The CONTRACTOR shall restore all cuts, trenches, and openings to the original condition. Grass surfaces shall be replaced with pre-grown, cut turf (sod, in accordance with section 813 of the SSHC), in existing lawns. Seeding shall be performed in accordance with the Standard Specifications of Highway Construction Edition of 2007 as listed below. Other dirt areas shall be raked, seeded, and fertilized. While care should have been used to avoid them, any damaged trees and shrubs shall be replaced (if directed by the ENGINEER). See seeding with straw or hay mulch and sod specifications for restoration pay items.
- n. Method A: Seeding with Straw or Hay Mulch: Sow seed as specified in Method A of **Subsection 810.4.11**. Within 24 hours following covering of the seed, uniformly apply straw or hay mulch material at the rate of 2 tons per acre. Spread mulch by hand, by appropriate mechanical spreaders, or by blowers. Use mulch that allows sunlight to penetrate and air to circulate but also partially shades the ground and conserves soil moisture. To be paid at the line item for 8101000 Seeding (Mulched) MSY.
- o. Sod: Provide sod that consists of living, well-established growth, predominantly of the grass specified in the Special Provisions. Provide vigorous, well rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and any other harmful or detrimental materials. To be paid at the line item for: 8131000 Sodding MSY.
- p. Rock Boring: When SCDOA Fiber design anticipates rock being encountered or the ENGINEER deems it necessary rock boring techniques will be used. The Rock Boring method shall be approved by the ENGINEER and shall in no way crumple or damage the conduit.



- q. Bridge attachment: When attaching to a bridge, rigid galvanized steel conduit shall be used. Conduit supports and hardware shall be Stainless steel and installed using an approved epoxy anchor. Conduit supports shall be installed a maximum of 5 feet apart and bent closed at the bottom. Conduit straps shall be two-hole heavy duty stainless steel. Conduit shall have approved heavy duty galvanized steel expansion couplings at every expansion joint in bridge. Approved in line stainless steel pull boxes shall be installed on bridge attachments for pull points that are over 500 feet at no additional cost to the DEPARTMENT. There shall be a service box set at both ends of bridge to make transition from PVC or HDPE conduit to ridged galvanized steel conduit for bridge crossing. All conduit, expansion couplings, couplings, conduit supports, bolts, nuts, anchors, epoxy, unions, and all other incidental material will be included in the pay item for LF Bridge attachment.
- r. Proofing: Prior to installing cable or fiber into conduit and DEPARTMENT acceptance the conduit must be proofed. Proofing the existing conduit ensures that all obstructions are cleared and that conduit continuity and alignment is good. A rigid mandrel designed for HDPE roughly 90% of the inner diameter of the conduit shall be used to perform the proof. Proofing conduit is typically performed by pushing or pulling a rigid mandrel attached to the end of a pull line or fiberglass rod and pulled or pushed through the conduit. If the mandrel makes its way through the conduit without any difficulties experienced, then the conduit has "proofed out," and no repairs should be necessary. If it does not make it through the conduit, it must be repaired prior to installing cable or fiber and prior to acceptance. All conduit must be proofed prior to final acceptance.

#### **EROSION CONTROL**

K.

1. **DESCRIPTION:** THIS SECTION CONTAINS SPECIFICATIONS FOR THE MATERIALS, EQUIPMENT, CONSTRUCTION, MEASUREMENT, AND PAYMENT FOR THE PLACEMENT OF TEMPORARY EROSION CONTROL MEASURES TO PREVENT EROSION AND WATER POLLUTION THROUGH THE USE OF BEST MANAGEMENT PRACTICES INCLUDING THE USE OF ROLLED EROSION CONTROL PRODUCTS, SILT FENCES, SEDIMENT TUBES, AND TEMPORARY SEEDING IN CONFORMITY WITH THE PLANS THE SPECIFICATIONS, SCDOT STANDARD DRAWINGS, OR AS DIRECTED BY THE RCE.
2. **SEDIMENT TUBES:** SEDIMENT TUBES ARE TEMPORARY EROSION CONTROL DEVICES INSTALLED ALONG CONTOURS, IN DRAINAGE CONVEYANCE SWALES, AND AROUND DRAINAGE INLETS TO REDUCE THE EFFECTS OF SOIL EROSION AND TO RETAIN SEDIMENT. LOCATIONS FOR INSTALLATION WILL BE DESIGNATED ON THE PLANS OR BY THE RCE 8152007 SEDIMENT TUBE LF
3. **SILT FENCES:** CONSTRUCT THE SILT FENCE IN ACCORDANCE WITH PLANS OR SCDOT STANDARD DRAWINGS OR AS APPROVED BY THE RCE. PLACE SILT FENCES BEFORE THE MAJOR CONSTRUCTION IN AN AREA IS STARTED.

Maintain the silt fence until its capacity has been reached or erosion activity in the area has stabilized. Remove sediment accumulated along the fence when it reaches approximately one-third of the height of the fence, especially if heavy rains are expected. Remove trapped sediment or stabilize on site.

Inspect the silt fence every 7 days. Immediately correct any deficiencies. Remove filter fabric and replace whenever it has deteriorated to such extent that it reduces the effectiveness of the silt fence. In addition, review daily the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Install additional silt fences as directed by the RCE where deficiencies exist.

If a silt fence or portion of a fence is located in an area where removing the sediment is not possible, then install a second silt fence, if necessary, at the discretion of the RCE. In this case, payment for both silt fences and portions involved is made at the unit price for silt fence.

Remove silt fence within 30 days after final stabilization is achieved or after temporary Best Management Practices (BMP) are no longer needed. Permanently stabilize disturbed areas resulting from fence removal. The fence materials remain the property of the CONTRACTOR and may be used at other locations provided the materials meet the appropriate requirements contained in this specification and/or on the Plans.

Silt Fence LF

Replace/Repair Silt Fence LF

#### **4. TURF REINFORCEMENT MATTING (TRM)**

- a. Type 1: Provide a Type 1 TRM consisting of a web of mechanically or melt bonded polymer netting, monofilaments or fibers entangled to form a strong three-dimensional stable net structure utilizing bonding methods including polymer welding, thermal or polymer fusion or the placement of fibers between two high-strength biaxial oriented nets mechanically bound by parallel stitching with polyolefin thread. The RCE may allow a degradable fiber matrix to be used to provide immediate coverage for bare soil.
- b. Type 2: Provide a Type 2 TRM consisting of a web of mechanically or melt bonded polymer netting, monofilaments or fibers that are entangled to form a strong three-dimensional stable net structure utilizing bonding methods including polymer welding, thermal or polymer fusion or the placement of fibers between two high-strength biaxial oriented nets mechanically bound by parallel stitching with polyolefin thread. The RCE may allow a degradable fiber matrix to provide immediate coverage for bare soil.
- c. Type 3: Provide a Type 3 TRM consisting of a web of mechanically or melt bonded polymer netting, monofilaments or fibers that are entangled to form a strong three-dimensional stable net structure utilizing bonding methods including polymer welding, thermal or polymer fusion or the placement of fibers between two high-strength biaxial oriented nets mechanically bound by parallel stitching with polyolefin thread. Do not use a TRM manufactured from discontinuous or glued netting in this category. Ensure that the material is 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.
- d. Type 4 (High Survivability): Provide a Type 4 TRM consisting of a geosynthetic matrix that exhibits a very high interlock and reinforcement capacities with both soil and root systems, demonstrates a high tensile modulus, and is specially designed for erosion control applications on steepened slopes and vegetated waterways. Do not use a TRM manufactured from discontinuous netting, netting loosely held together by stitches or glue, or composites. Ensure that the material is 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. Furnish a Type 4 TRM with high loading and/or high survivability capabilities for field conditions such as long-term maintenance, structural backfills protecting critical structures, utility cuts, and traffic areas with the potential for high abrasion, higher required factors of safety, and/or general durability concerns

Turf Reinforcement Matting (TRM) Type 1 MSY

L.

Turf Reinforcement Matting (TRM) Type 2 MSY

Turf Reinforcement Matting (TRM) Type 3 MSY

Turf Reinforcement Matting (TRM) Type 4 MSY

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

**DESCRIPTION:** THIS ITEM SHALL CONSIST OF FURNISHING AND INSTALLING SINGLE-MODE FIBER OPTIC (SMFO) CABLE IN CONDUIT. THE PAY ITEM FURNISH AND INSTALL FIBER OPTIC CABLE ALSO INCLUDES ALL ITEMS AND EXPENSES ASSOCIATED WITH THE ITEMS LABELED FIBER OPTIC COMMUNICATION PLANT – TESTING, FURNISH AND INSTALL FIBER INTERCONNECT CENTERS AND CLOSURES. THE CONTRACTOR SHALL FURNISH ALL ATTACHMENT HARDWARE, SPLICE ENCLOSURES AND INSTALLATION GUIDES NECESSARY TO INSTALL THE FIBER OPTIC CABLE.

CABLE SHALL BE PRYSMIAN FLEXLINK MATCHING THE EXISTING PRYSMIAN SM FIBER. CONTRACTOR SHALL HAVE INDEX OF REFRACTION LABELED ON AS-BUILT FOR ALL FIBER CABLE.

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

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

Fiber Coating	Corning CPC6 or approved equal
Cladding Diameter:	125.0 + 1.0 $\mu$ m by fiber end measurement
Outer Coating Diameter	245 $\pm$ 5 $\mu$ m
Core-Clad Concentricity	$\leq$ 0.5 $\mu$ m
Cladding Non-Circularity:	$\leq$ 1.0%
Fiber Curl	$\geq$ 4.0m radius of curvature
Index of Refraction 1310/1550 nm	1.4693/1.4690
Mode field diameter – 1310	9.2 $\pm$ 0.4 $\mu$ m
Mode field diameter – 1550	10.5 $\pm$ 1.0 $\mu$ m
Cable Cutoff Wavelength	ccf $\leq$ 1260nm
Refractive Index Profile	Matched clad, step index
Zero Dispersion Wavelength	1304nm $\leq \pm 0 \leq$ 1324 nm
Zero Dispersion Slope	<0.092 ps (km-nm)
Dispersion 1330 nm	<3.5ps/( nm-km)
Dispersion 1550 nm	<18ps/(nm-km)
Point Discontinuity	$\leq$ 0.10 dB at 1310 and 1550 nm
Attenuation at Water Peak (Uncabled Fiber)	<1.5 dB/km at 1383 $\pm$ 3nm
Attenuation vs. Wavelength	1285 $\leq$ 1310 $\leq$ 1330nm – 0.05 dB/km
	1525 $\leq$ 1550 $\leq$ 1575 nm – 0.05 dB/km
Attenuation vs. Bending	1 turn (32 mm) at 1550nm $\leq$ 0.50 dB
	100 turns (50mm) at 1550nm $\leq$ 0.10dB
Polarization Mode Dispersion Coefficient	$\leq$ 0.2 ps/ $\sqrt$ km
Temperature Cycling	$\leq$ 0.05 dB/km (-40 C to 85 C)
Temperature-Humidity Cycling	$\leq$ 0.05 dB/km – 10 C to 85 C, 4 to 98% RH
Water immersion, 23 C	$\leq$ 0.05 dB/ km
Heat Aging, 85 C	$\leq$ 0.05 dB/ km
Proof Test	$\geq$ 100 kpsi

2. Fiber Characteristics

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

All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements to this specification. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

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

Optical fibers shall be placed inside a loose buffer tube.

TEN (10) buffer tubes, each containing twelve (12) single-mode fibers shall be furnished. The fibers shall not adhere to the inside of the buffer tube.

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

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

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

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

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

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

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

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

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

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

Tensile strength shall be provided by high tensile strength aramid yarns and fiberglass. The high tensile strength aramid yarns/fiberglass shall be vertically stranded evenly around the cable core. All cable shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over

the tensile strength members and flooding compound. The jacket or sheath shall be free of holes, pits and blisters.

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

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

### 3. Quality Assurance Provisions

All optic fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

All optical fibers longer than 1,000 meters shall be 100% attenuation tested by the manufacturer. The attenuation of each fiber shall be provided with each cable reel. Fibers less than 1,000 meters shall be tested for continuity.

### 4. Splice Closure – Underground

a. Use: The closure shall be 3M brand only with no exceptions, designed for use under the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes as demonstrated by successful passing the factory test procedures and minimum specifications listed below. The closure will be installed inside service boxes. For more details see FURNISH AND INSTALL SERVICE BOXES. The closures shall be incidental to the fiber optic cable installation.

#### b. Physical Requirements

- 1) The closure shall handle up to four (4) cables in a butt configuration. A butt adapter may be used to increase capacity to six (6) cables.
- 2) The closure shall prevent the intrusion of water without the use of encapsulate.
- 3) The closure shall be capable of accommodating splice organizer trays, which accept mechanical, fusion, or multi-fiber array splices. The splice closure shall have provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies; add space for excess or non-spliced fiber. Splice organizers shall be re-enterable. Splice cases shall hold a minimum of two (2) splice trays to a maximum of six (6) splice trays, with each tray housing 24 splices.
- 4) Closure re-entry and subsequent reassemble shall not require specialized tools or equipment. Further, these operations shall not require the use of additional parts.
- 5) The splice closure shall have provisions for controlling the fiber bend radius to a minimum of 38 mm.

5. CERTIFICATION: The CONTRACTOR shall provide certified test results from the manufacturer showing the cable furnished has been tested. The test shall be approved by SCDOT prior to its implementation. **Note: Catalog cuts shall be submitted at pre-con.**

### 6. LABELING AND DELIVERY

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

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

### 7. CONSTRUCTION METHODS

#### a. General

The CONTRACTOR shall take every precaution to ensure the fiber optic cable is not damaged during storage and installation. The fiber optic cable shall not be stepped on

by workers or run over by any vehicle or equipment. The fiber optic cable shall not be pulled along the ground, or over or around obstructions.

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

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

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

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

Table 1  
Fiber Optic Minimum Bend Radius Chart

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

In the case where the plans call for fiber optic installations in conduit, the 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 installed 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 vehicular traffic yet ensures that no damage to the cable shall occur. The cable shall be stored in a manner that shall allow that length of cable to be safely pulled into the next conduit. The ENGINEER shall approve the storing methods to be used.

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

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

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

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

b. Aerial Installation

1) General

All fiber optic cable installation shall be in buried conduit.

c. Underground Installation

Where shown on the Plans, the fiber optic cable shall be installed in new or existing underground conduit, 36" deep.

1) Conduit

Conduit size and type are specified on the Plans. For additional information concerning conduit see FURNISH AND INSTALL CONDUIT. This section concerns the procedure for installing cable inside the conduit.

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

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

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

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

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

The CONTRACTOR shall pull an adequate amount of fiber optic cable into the various cabinets and service boxes. The following table shows the amount of slack cable that should be provided in the various type of cabinets and service boxes:

a) Service boxes	100 feet
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The length of slack for each of these cabinet types should be divided evenly between entering and exiting cable. For example, service boxes should have 100 feet of slack on the exiting and 100 feet of slack on the entering cable for a total of 200 feet. Maintenance loops should follow the same cable slack measurements listed for service boxes. 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.

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. The grounding or bonding conductor shall be #6 AWG bare stranded copper wire.

Bonding of metallic conduit in service 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.

## 2) Buried Cable Markers

Buried cable markers shall be located along the buried cable line at locations shown on the Plans and/or shall be placed at every service box and not more than every 2450 feet apart. The marker shall be a PNA dome pack post cable marker 3" in dia., 6' long with a 16" orange top with approved labeling and phone number (labeling information and phone number to be supplied by ENGINEER for each project) or approved equal. An Orange passive marker ball shall be placed in every service box containing fiber or communications cable with a frequency of 101.4KHZ, that is compatible with a MetroMark passive marker locator 760Dx or approved equal.

## 8. SPECIAL INSTRUCTIONS TO CONTRACTORS

- a. Fiber optic cable, of the type and size specified, will be measured by the linear foot of cable actually furnished and installed, completely in place and accepted, using an optical time-domain reflectometer (OTDR).
- b. The jacket shall have "Grabber" brand cable (stock no. VF0G – 07) markers. The markers shall be six (6) inches long, orange in color and read as follows in black: "SCDOA FIBER OPTIC CABLE (803) 737-1893". Two Grabber brand cable markers shall be placed on cable in each service box and shall be visible when the lid is removed.
- c. The SMFO cable shall be spliced only at those points shown in the Plans or as approved by SCDOA (minimum distance between reel end or end-to-end splices shall be no less than 15,000 feet of cable length). Back bone cable shall not have intermediate splices. The designated splices shall be in the fiber interconnect centers that are proposed for installation in the service boxes as designated on the Plans. If fiber optic cable splice locations are not labeled on the plans, SCDOA shall designate where splices will be allowed. The CONTRACTOR shall order cable in reel lengths that are of sufficient length (>15,000') to require no intermediate splicing of the cable.
- d. The CONTRACTOR shall furnish and install single-mode fiber optic cable as the transmission medium for the video signals, the data communications trunk, and the data communication channels between the field devices and the hub building. The CONTRACTOR shall furnish, install, splice, and test all the fiber optic cables. No separate payment shall be made for furnishing and installing splicing kits, fiber optic cable caps, breakaway swivels, moisture sealants, terminators, splice trays, fiber connector panels, jumper cables, connectors, and accessories to complete the fiber optic network. These items shall be considered as incidental, and their costs shall be included in the cost to furnish and install the fiber optic cable. No separate payment will be made for equipment used by the CONTRACTOR to install, splice, and test the fiber optic cable, the cost of which shall be included in the unit price to furnish and install the cable.

## 9. TRAINING



The CONTRACTOR will be required to furnish training for the testing and maintenance of the fiber optic infrastructure installed on this contract. The training will consist of classroom and "hands-on" training. The Training will be ETA and IMSA compliant and will include ETA FOI, and IMSA Fiber Optics for Traffic Systems Tech Levels I and II certification testing and certifications for each SCDOT employee in attendance.

Training will be furnished as part of the Furnish and Install Fiber Optic Cable bid item with no additional cost to the DEPARTMENT.

- a. The classroom training will consist of a minimum 40 hours (or as required to achieve certifications for both ETA FOI and IMSA Levels I and II) of classroom instruction for up to ten (10) SCDOT/SCDOA maintenance personnel and will include hands-on training, ETA and IMSA Fiber Optic Technician certification testing, certifications and written instruction. The DEPARTMENT reserves the right to allow others to attend training.
- b. The testing and maintenance training will be conducted at the ITS Maintenance Facility in Columbia, SC. Training dates and times shall be approved by the ITS Field Operations Manager prior to scheduling. A list of attendees will be given to the CONTRACTOR by the ITS Field Operations Manager for scheduling and testing purposes. Training shall be scheduled on a date selected by ITS Field Operations Manager during the project (CONTRACTOR should note that this training may be required at the beginning of the project; however, it must be conducted prior to Substantial Completion of ITS infrastructure for this contract.)

### **CATALOG CUTS ARE REQUIRED**

#### **FIBER OPTIC COMMUNICATION PLANT - TESTING**

M.

Description: The CONTRACTOR shall test the fiber optic cable before and after installation in accordance with the procedures in this project's special provisions. The results of the tests shall be provided to the DEPARTMENT'S project resident construction engineer (RCE). The CONTRACTOR shall test all used or spare/unused fibers.

##### **1. FIBER OPTIC CABLE TEST**

- a. Continuity: Prior to the installation of any fiber optic cable, the CONTRACTOR shall test the continuity of each fiber using an optical time domain reflectometer (OTDR). The test shall be conducted while the fiber is still on the reel and the test results shall be provided to the RCE.
- b. 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  $>0.05$  dB shall be re-spliced.

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

- c. Connector/End Splice Testing: The CONTRACTOR shall test each connector/end splice loss bi-directionally 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.
- d. 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 bi-directionally in accordance with EIA/TIA 526-7.

The CONTRACTOR shall provide hardcopy test results to SCDOA 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 to the Department three hard copies and three electronic copies on CD of the OTDR test results of all fiber optic cable installed on project. CONTRACTOR will supply to the Department any software required to open the OTDR electronic files at no additional cost to the Department.

The CONTRACTOR shall provide OTDR signature traces of all fibers between all CCTV locations and ITS control centers for system documentation and restoration purposes.

## **FURNISH AND INSTALL FIBER INTERCONNECT CENTERS AND CLOSURES**

N. Description: **This item is to be included in the cost for FURNISH AND INSTALL FIBER OPTIC CABLE.** These items shall consist of furnishing and installing fiber interconnect centers and fiber optic interconnect closures. All in-ground (below grade) **Splice Enclosures shall be of the 3M brand**, no exceptions. Included in these items are the splicing of the fiber optic cable; furnishing and installing splice trays, interconnection sleeves, jumpers, connectors, and other hardware that may be needed to house the coiled fiber optic cable and the fiber optic splices. The centers and closures will have a varying number of splice trays and splices and shall be housed inside service boxes at reel termination points. GPS location shall be provided for mid spans/reel end splices and shown on as-built plans.

### **1. MATERIALS**

The CONTRACTOR shall provide 3M splice closures at locations for reel end splices. The fiber interconnect centers shall include strain-relief hardware, be rack-mountable and typically have the following capacities and locations:

The fiber optic 3M brand closures shall typically have the following capacities and locations:

- a. At fiber optic backbone reel end locations with a 144-splice closure capacity.

The fiber interconnect center and closures shall be located in service boxes such that the slack fiber optic cable stored on top of the fiber interconnect center (as required in the Special Provision – Furnish and Install Fiber Optic Cable) can be easily removed (along with the fiber interconnect center) from the cabinet and taken to a maintenance vehicle for splicing, if necessary.

The interconnect centers shall be equipped with fiber connector panels with factory-installed interconnection sleeves. The interconnection panels shall be clearly labeled (transmit/receive). The interconnection sleeves shall be type ST compatible, with ceramic insert, and composite housing for single- mode fiber optic cable. The trays shall be a Siecor type or approved equivalent.

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

### **2. SPLICING OF THE FIBER OPTIC CABLE**

- a. Splicing Methods

All splicing shall be done by means of a fusion-splice technique, which induces less than 0.09 dB attenuation. Bare fibers shall be completely recoated with a protective RTV gel or similar substance prior to application of the sleeve or housing to protect the fiber from scoring, dirt, or microbending. Each spliced fiber shall be packaged in a heat-shrunk protective sleeve or housing. All splices shall be performed in accordance with the cable manufacturers and the splice manufacturer's recommendations. During splicing, the CONTRACTOR shall maintain the continuity of the buffer tube and fiber color.

Incoming fibers shall be provided with five (5) feet of coiled slack and spliced to a pigtail of the same type of fiber. Pigtails shall have a minimum length of five (5) feet and shall have a factory-installed UPC-ST compatible connector. The pigtails shall have an attenuation of less than 0.5 dB. The UPC-ST connector shall mate with the connector panels installed in the fiber interconnect center.

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

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

The CONTRACTOR shall label all fiber optic patch panels and jumpers. Labeling shall match DMS and Camera addressing numbers. If fiber port is unassigned, the fiber destination location shall be used for labeling. The labeling shall be approved by the ENGINEER.

b. Jumpers

If necessary, the CONTRACTOR shall furnish and install single-mode fiber optic cable assemblies with UPC ST 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.

c. Future Applications

The fiber optic communications network is being designed and constructed to accommodate future applications. The CONTRACTOR shall only fusion splice the necessary fibers at local cabinet locations. However, the CONTRACTOR shall splice all fibers at reel end splices. All pigtail assemblies shall be connected by the CONTRACTOR to the connector panels installed in the fiber interconnect center. The transmit and receive designations of each fiber pair shall be clearly labeled on the front of the connector panel. Each fiber termination/connection shall be tested for attenuation.

o.

**FURNISH AND INSTALL SERVICE BOXES**

DESCRIPTION – This work shall consist of furnishing and installing SERVICE BOXES at the locations determined by the CONTRACTOR and SCDOT and in accordance with these Specifications. The service box shall consist of a box and cover, installed over a min. 6 inches of aggregate. The service box is intended for coiling of fiber optic cable and future splice of the fiber optic cable near bridge decks. The CONTRACTOR is cautioned that some boxes may be installed over existing conduit with existing cable. The CONTRACTOR is responsible for installation without damage to the existing items. Any damage shall be repaired by the CONTRACTOR at no cost to the Department. Any damage to the existing fiber optic cable shall be repaired within twelve (12) hours of damage. A penalty of \$100.00 per hour shall be imposed for every hour past twelve that it takes to repair existing fiber cable. Service boxes shall be Armorcast A6001430TAPCX30 or High Line HIGHLINEPHA30483H04 furnished with a two-piece non-skid cover or approved equal. It shall be installed on in the dirt, at the depth so as the top is flush with the ground. GPS location shall be provided for all boxes and shown on as-built plans.

1. Materials

Shall meet the following requirements:

a. Box and Cover

The service boxes shall consist of a base having an open top (the box), with a separate removable two-piece cover. They shall be GRAY IN COLOR. Two-piece covers shall have the LEGEND "SCDOT Fiber optic" or "SCDOT Electrical", as required. They shall use HEX-HEAD stainless steel bolts. The PHYSICAL FEATURES AND THE NOMINAL

SIZE AND DIMENSIONS for the box and cover, are shown on the Standards or the Design Details, and are listed below:

	WIDTH	LENGTH	DEPTH
SERVICE BOX:	30in.	48in.	30in.

(Service, Splice box for fiber optics and for electric services when deemed necessary by the ENGINEER)

b. Design Load

Boxes shall be designed to survive a tandem wheel load specified by AASHTO H 20-44, being 32,000 pounds (14,514.9 kg) per axle, or 16,000 pounds (7257.6 kg) per tandem wheel pair. This 16,000 pound (7257.6 kg) dead load shall be multiplied by 1.3 impact factor, to obtain the DESIGN TEST LOAD OF 20,800 pounds (9434.7 kg). Thus, boxes shall be designed and tested for the following test loads: Cover – vertical load 20,800 pounds distributed over a 10 in. x 20 in. area (9434.7 kg over .254 x .508 m). Box – vertical load 20,800 pounds distributed over a 5 in. x 20 in. area (9434.7 kg over .127 x .508 m). Box – lateral load of 600 pounds per square foot (28728 Pascals). The cover deflection shall be less than 0.5 inch (1.27 cm); and the box deflection less than 0.25 in./ft. of length (.635 cm/.3 m). (Because of quoted references, English units are first.)

c. Western Underground Committee (WUC)

Using the above specified loads, the service boxes shall meet or exceed the WUC "Recommended Guide No. 3.6, Non-Concrete Enclosures". Structural requirements shall include: testing for vertical load on cover; vertical load on box; lateral load on box. Further they shall meet WUC recommendations for: accelerated service per ASTM D-756; chemical resistance per ASTM D-543; simulated sunlight resistance per ASTM G-53; plus water absorption; and flammability. Covers shall be skid-resistant, with a minimum coefficient of friction of 0.5.

d. Concrete

Concrete for patching shall be DHPT Class A, mixed and installed in accordance with Section 700 of the Standard Specifications.

e. Aggregate

Crushed stone for the service box shall be DHPT Aggregate Numbers 5 or 57. Service boxes shall be set on a min.36" X 54" bed of aggregate, min. 6 inches deep.

2. Certification

- a. The Bidder shall provide certification from the manufacturer or vendor that the above material specifications have been met, including written results for Western Underground Committee tests.

NOTE: CATALOG CUTS ARE REQUIRED.

- b. The CONTRACTOR shall provide the DEPARTMENT with all guarantees offered by the manufacturer.

3. Construction Methods

a. Construction

- 1) The service boxes shall be constructed as indicated in the Design Details or the Standards, at locations shown on the Plans.
- 2) The service boxes shall be constructed such that when the box and covers are in place, they are flush with the adjacent pavement, ground, or sidewalk, as shown in the Design Details or the Standards. Patching concrete shall be placed around any box installed in pavement.

- 3) Boxes shall be placed at least 0.3 meters (1 foot) behind the curb-line or edge of roadway or as shown on the Plans.
- b. Conduit
    - 1) See FURNISH AND INSTALL CONDUIT Specifications.
    - 2) Conduit shall enter the box at the bottom and extend at least six inches above the aggregate.
    - 3) Conduit shall enter from the direction of the run unless otherwise permitted by the ENGINEER.
    - 4) All metallic conduit ends within the box shall have grounding bushings with plastic inserts; and shall be bonded with one another with #6 AWG bare copper ground wire. PVC conduits greater than 3" shall have end bushings to prevent chaffing.
    - 5) After the electrical/communication cable is placed, the completed conduit ends shall be packed with "duct-seal" or other equivalent material to prevent water from entering the conduit. Spare conduit shall be capped.
  - c. Grounding
    - 1) Service box shall have one 5/8" X 8' copper clad ground rod installed for grounding of detectible muletape or tracer wire for fiber optic cable. The Detectable muletape conductors shall be bonded to the ground rod with a mechanical ground rod connector. Ground rod shall be installed so that the top of the ground rod is 6 to 8 inches below the box lid (allowing easy access for locating personnel to connect inductance equipment to tracer wire). There shall be a min. three feet of slack on detectible muletape.
    - 2) All service boxes shall have accurate GPS coordinates with accuracy of 3 feet or less marked on as-built plans. GPS coordinates shall be obtained using a Department approved device. All service boxes shall have a red or orange passive marker ball with a frequency of either 101.4KHZ for fiber or 169.8KHZ for electrical that is compatible with a MetroMark passive marker locator 760Dx or approved equal. All service boxes shall have a 16" RED or ORANGE Top (as required) above ground cable marker type PNA Dome Pack cable post marker 3" dia., 6' long or approved equal.

P.

#### **CATALOG CUTS ARE REQUIRED**

#### **REMOVAL SALVAGE AND DISPOSAL OF EQUIPMENT AND MATERIALS**

DESCRIPTION – This item consists of the Removal and Salvage, or the Removal and Disposal of equipment and materials, during the construction of this project. Construction includes the modification, or removal of existing ITS devices and infrastructure. It shall be disposed of, as stated below:

##### **1. GENERAL**

###### **a. Removal and Salvage**

These items are to be carefully removed from the job site, salvaged, and returned to the Department. The items of major equipment to be salvaged are listed on the Plans. The CONTRACTOR shall deliver, (and obtain a RECEIPT for), the salvaged equipment, to: \*\*SCDOT Intelligent Transportation Systems Maintenance Facility\*\* in Columbia, SC. Contact the ITS Field Operations Manager at (803)-737-0394 for deliveries.

###### **b. Disposal**

Material NOT to be salvaged shall be removed from the job site, become the property of the CONTRACTOR, and should be properly disposed of by the CONTRACTOR, at an APPROVED LAND FILL (or material reclamation yard). Any materials designated

as HAZARDOUS WASTE shall be disposed in accordance with regulations enforced by the SC Department of Health and Environmental Control (DHEC) and its successor agencies, Bureau of Solid and HAZARDOUS Waste. Contact (803)-734-5000 for information.

c. Inspection

Removal and disposal quantities will not be measured as pay items but shall be included in the price bid for Removal, Salvage, and Disposal. FINAL ACCEPTANCE and Final Payment will be withheld if the CONTRACTOR has not removed unneeded equipment from the job site and if the CONTRACTOR cannot present RECEIPTS from the Shop showing that the salvaged equipment has been delivered to the Department as specified.

d. Holes

Every hole caused by removing old equipment shall be filled THE SAME DAY. It shall be backfilled, compacted, and reseeded/sodded, to the satisfaction of the ENGINEER. Holes in PAVEMENT shall be cleanly side-trimmed, then brought to grade and finished with the same paving material as the adjacent pavement. Sidewalk "squares" shall be completely replaced (complete square), using forms and expansion material.

2. SPECIFIC ITEMS

a. Controllers and Cabinets

Controllers and Cabinets are to be removed by the Department. CONTRACTOR is to be responsible for the foundations of ground-mounted cabinets and shall be removed completely or cleared to 0.3 meters (1 ft.) below ground.

b. Cameras

Camera units are to be removed by the Department, and salvaged shall be carefully dismantled.

c. Wood Poles

Wood Poles that are not utilized in the new ITS system and are not required by other utilities shall be removed and disposed of. Back guys, grounding systems, and miscellaneous hardware shall be disposed of.

d. Concrete Poles

Concrete poles shall be removed and disposed of by CONTRACTOR.

e. Miscellaneous Equipment

Minor equipment shall be removed from the site and discarded. This includes steel cable, electrical cable, fiber optic cable, concrete pads, and splice boxes/pull boxes/hand boxes. Underground conduit and detector loops not utilized shall be abandoned in place.

f. DMS and Structures

The DMS shall be carefully removed and turned in to the Department. Care shall be taken to ensure the DMS sign is not damaged during removal or delivery to the ITS Field Operations Office. The structure shall be removed and disposed of by the CONTRACTOR.

Q.

**SCDOT INTELLIGENT TRANSPORTATION SYSTEMS SPECIFICATIONS FOR THE REPLACEMENT OR NEW INSTALLATION OF TRAFFIC COUNTING, OR CLASSIFICATION SYSTEMS**

**GENERAL DESCRIPTION**

This work shall be performed by the SCDOT Intelligent Transportation Systems (ITS) Staff and the on-call ITS Maintenance/Installation Contractor. All equipment and labor will be provided by the ITS Field Operations Unit. Contact the ITS Field Operations Manager located at 1408 Shop Rd., Columbia, SC 29201 at (803) 737-1163 for cost estimates, scheduling, reclaiming, reinstallations, maintenance and installations.