November 3, 2016

SPECIAL PROVISIONS
FOR
SECTION 750-A: FIBER OPTIC CABLE AND INTERCONNECT

The 2014 Edition of the New Mexico Department of Transportation Standard Specifications for Highway and Bridge Construction shall apply in addition to the following:

1.0 DESCRIPTION.

1.01 Furnish and install a fiber optic cable system and power line as shown in the plans.

2.0 MATERIALS.

2.01 Fiber Optic Cable. Provide all-dielectric, gel-filled, loose-tube, SR 15E - bend-insensitive, single-mode fiber (SMF) with low water peak, and suitable for underground (i.e., in conduit) and aerial outside plant installation. All fiber optic cable shall be splice-compatible with the Department's existing SMF and require no electronic equipment for dispersion compensation between new and existing fiber. Ensure that all components that comprise a single length of cable are continuous and of the same material. Furnish only commercial off-the-shelf materials, equipment, and components.

2.01.1 Optical Fiber. Ensure that the optical fibers used in the cable meet or exceed the Telecommunications Industry Association (TIA) and Electronic Industries Alliance (EIA) TIA/EIA-492-CAAB specification. Use only optical fibers meeting the additional requirements as follows:

Mode field Diameter At 1310 nm	8.6±0.4μm
Cladding Diameter	125.0±0.7μm
Coating Diameter (uncolored)	245±5μm
Core concentricity error	≤ 0.8 μm
Cladding no-circularity	≤1.0%
Cladding/coating concentricity error	≤ 12.5 μm

Attenuation Coefficient	
At 1310 nm	≤ 0.35 dB/km
At 1550 nm	≤ 0.22 dB/km
At 1383 nm	≤ 0.31 dB/km (Type A)
Cable cut-off wavelength	≤ 1260 nm
Chromatic Dispersion Coefficient	
At 1285 – 1330 nm	≤ 3.5 ps/(nm·km)
At 1270 – 1340 nm	≤ 5.3 ps/(nm·km)
At 1550 nm	≤ 18 ps/(nm·km)
Zero-dispersion wavelength	1300 – 1324 nm

Zero-dispersion slope	≤ 0.092 ps/(nm2·km)
PMD link design value	≤ 0.08 ps/√ km

Proof Test	150 kpsi
Dynamic Stress Corrosion Susceptibility Parameter	≥ 20
Coating Strippability	1.3 – 8.9 N
Fiber Curl Radius	≥ 4.0 m
Permissible Bending Radius	≥ 15 mm

Ensure that each optical fiber is glass and consists of a germania-doped silica core surrounded by concentric silica cladding. Ensure that all fiber in the buffer tube is usable fiber that complies with attenuation requirements. Ensure that fibers do not adhere to each other. Ensure that the fiber is free of surface imperfections and inclusions. Ensure that all fiber optic core glass is from the same manufacturer.

2.01.2 Buffer Tubes. Ensure that the fiber optic cable includes loose buffer tubes that isolate internal optical fibers from outside forces and provide protection from physical damage as well as water ingress and migration. Ensure that buffer tubes provide freedom of movement for internal optical fibers. Ensure buffer tubes allow for expansion and contraction of the cable without damage to internal optical fiber. Ensure that fiber does not adhere to the inside of the tube. Ensure that buffer tubes permit intentional scoring and breakout without damage to the fiber. Ensure that each fiber optic cable buffer tube contains 12 fibers per tube unless otherwise noted in the plans.

2.01.3 Color Code. Ensure that the marking and color-coding of the fibers and buffer tubes conforms to telecommunication industry requirements as detailed in the TIA/EIA-598-C standard. Ensure that colors are permanent and stable during temperature cycling, and not subject to fading or smearing onto each other or into the water-blocking material. Ensure that fibers are colored with UV curable inks that remain clearly distinguishable as the intended color.

2.01.4 Strength Member. Ensure that the fiber optic cable contains a dielectric central strength member and dielectric outside strength member to prevent buckling of the cable and provide tensile strength. Ensure that the fiber optic cable can withstand a pulling tension of 600 pounds during installation without increasing the fiber attenuation more than 0.8 decibel per mile, without changing other optical fiber characteristics after the tensile load is removed, and without damage to any components of the fiber optic cable.

2.01.5 Water Blocking Compound. Ensure that the fiber optic cable contains a dry water-blocking material to prevent the ingress of water within the outer cable jacket. Ensure that the water-blocking tapes and yarns are non-nutritive, dielectric, and homogeneous, and free from dirt and foreign matter. Use dry water-blocking material for fiber optic cables used for either aerial or underground installations. Apply dry water-blocking compound longitudinally around the outside of the central buffer tubes. Construct all cables with water-blocking tape that complies with the requirements of the EIA/TIA-455-81B standard and is subjected to water penetration tests as defined in the EIA/TIA-455-82B standard.

2.01.6 Ripcord. Ensure that the cable contains at least one ripcord under the sheath. Ensure that the ripcord permits the removal of the sheath by hand or with pliers.

2.01.7 Filler. Fillers or rods may be included in the cable core to lend symmetry to the cable cross section if

required.

2.01.8 Outer Jacket. Ensure that the fiber optic cable is jacketed with medium density polyethylene (MDPE) that is free of blisters, cracks, holes, and other deformities. Ensure that the nominal jacket thickness is a minimum of 0.03 inch. Apply the jacketing material directly over the tensile strength members and water-blocking material. Ensure that the MDPE contains carbon black to provide ultraviolet (UV) protection and does not promote the growth of fungus.

Mark the jacket with the cable manufacturer's name, fiber type, fiber count, and date of manufacture, the words "NMDOT FIBER OPTIC CABLE," and the sequential cable lengths marked in feet. Ensure that the actual length of the cable is within 1% of the length indicated by the marking. Provide legible marking with contrasting color to that of the cable jacket.

2.01.9 Performance Requirements.

2.01.9.1 Operating Temperature. Ensure that the shipping and the operating temperature range of fiber optic cable meets or exceeds -30º to 150º F as defined in the environmental requirements section of the NEMA TS 2 standard. Ensure that the installation temperature range of fiber optic cable meets or exceeds -22º to 150º F.

2.01.9.2 Bend radius. Ensure that the fiber optic cable is capable of withstanding a minimum unloaded bend radius of 10 times the cable diameter and a minimum loaded bend radius of 20 times the cable diameter when loaded to pulling tension of 600 pounds. Test the cable as required in the EIA-455-33A standard. Ensure that bending the fiber optic cable up to the minimum bend radius does not affect the optical characteristics of the fiber.

2.01.9.3 Cable Strength. Ensure that the fiber optic cable is capable of withstanding a pulling tension of 600 pounds during installation without increasing the fiber attenuation more than 0.8 decibel per mile and without changing other optical fiber characteristics after the tensile load is removed. Ensure that optical fiber is proof-tested by the fiber manufacturer at a minimum of 100 kilo pounds per square inch. Ensure that the cable will withstand 25 impact cycles and the change in attenuation does not exceed 0.2 decibel at 1,550 nanometers when tested according to the requirements as detailed in the TIA/EIA-455-25B standard. Ensure that the fiber optic cable can withstand a minimum compression load of 125 pounds per square inch when applied uniformly over the length of the sample at the rate of 0.15 to 0.8 inch per minute and maintained for 10 minutes as defined in the TIA/EIA-455-41A standard. Ensure that the change in attenuation will not exceed 0.15 decibel during loading at 1,550 nanometers, and that no fiber displays a measurable change in attenuation after load removal.

2.01.9.4 Water Penetration. Ensure that the fiber optic cable is capable of withstanding the tests for water penetration defined in the TIA/EIA-455-82 standard. Ensure that a one-meter length of cable is able to withstand a one-meter static head of water applied at one end for 24 hours without water leaking through the other open cable end.

2.02 Splicing Materials. Ensure that all splice enclosures, organizers, cable end preparation tools, and procedures are compatible with the fiber optic cable, and are approved by the Engineer.

2.02.1 Splice Enclosures. Contain all optical fiber splices within a splice enclosure. Ensure that the enclosures provide storage for fiber splices, nonspliced fiber, and buffer tubes. Ensure that the splice enclosure restores the mechanical and environmental integrity of the fiber optic cable, encases the sheath opening in the cable, and organizes and stores optical fiber. Ensure all hinges and latching devices are stainless steel. Ensure that the

enclosure is airtight and prevents water intrusion. Ensure that the splice enclosure can accommodate pressurization and has the ability to be reentered without requiring specialized tools or equipment. Ensure that the enclosure provides fiber and splice organizers including splice trays and strain relief. Ensure that splice enclosures allow re-entry and are hermetically sealed to protect internal components from environmental hazards such as moisture, insects, and UV light. Fiber optic splice enclosures shall also comply with the Telcordia Technologies' GR-711-CORE standard and all applicable NEC requirements. Provide space for future expansion equal to 100% of the initial utilization. Provide fiber optic cable penetration end caps to accommodate a minimum installation of two trunk fiber optic cables and two fiber optic drop cables. Ensure that the enclosure end caps are factory-drilled to the proper diameter to accept and seal the fiber optic cable entries. Ensure that the cable entry locations can accommodate an assortment of cables with ODs ranging from 0.45 to 0.55 inch, +10%, without jeopardizing the waterproof characteristics of the enclosure. Provide fiber optic splice enclosures meeting the following requirements:

Mechanical
Resist compression deformation to a maximum of 400 pounds.
Withstand an impact energy to a maximum of 40 foot-pounds at 0° F.
Axial Tension: 100 pounds for 30 minutes.
Cable Torsion: ten 90-degree rotations.
Cable Flexing: ten 90-degree bends.
Environmental
Hydrostatic Pressure Head: Up to 20 foot-pounds (-9 pounds per square inch).
Withstand 40 freeze/thaw temperature cycles.
Ultraviolet resistant during a maximum 30-day exposure in compliance with the requirements detailed in the ASTM B117 standard.
Chemical
Withstand a 90-day exposure to solutions of 3% sulfuric acid, 0.2 normal of sodium hydroxide, 10% Igepal®, kerosene, and be fungus resistant as required in the ASTM G21 standard.

2.02.2 Splice Trays. Ensure that the splice trays are securely attached and accessible, and provide adequate storage for the fiber cable. Ensure the splice trays provide access to individual fibers without disrupting other fibers in the tray. Ensure that the splice trays hold the buffer tubes rigidly in place and provide protection for fusion splices. Ensure that the raceway accommodates the minimum bend radius of the fiber. Ensure that splice trays allow visible inspection of the fiber. Ensure that the splice tray includes a cover with a locking mechanism to hold it in place.

2.03 Cable Terminations. Use Type ST, SC, LC, or FC connectors only, as specified in the plans or by the Engineer. Ensure that all ST-type fiber optic connectors, whether factory pre-terminated or field-installed, are 0.1 inch physical contact with preradiused tips. Ensure that ST and FC connectors include a ceramic ferrule and a metallic body, and provide a strain relief mechanism when installed on a single fiber cable that contains strength elements.

Ensure that the ST-type connector provides minimum 50 pound pullout strength. Ensure that the optical fiber within the body of all connectors is mechanically isolated from cable tension, bending, and twisting.

Ensure that all connectors are compliant with the TIA/EIA-568-A and TIA/EIA-604 standards, as applicable, and are tested according to the Telcordia/Bellcore GR-326-CORE standard. When tested according to the TIA and

EIA's Fiber Optic Test Procedure (FOTP)-171 (TIA/EIA-455-171), ensure that the connectors test to an average insertion loss of ≤0.4 decibel and a maximum loss of ≤0.75 decibel. Test the connectors as detailed in FOTP-107 (TIA/EIA-455-107) to reflectance values of ≤ -50 decibels.

Ensure that the ST-type connectors have an operating and storage temperate range of -30° to 165° F as per the NEMA TS 2 standard.

2.03.1 Pre-terminated Connector Assemblies (pigtails). Ensure that pre-terminated connector assemblies are used for fiber termination. Ensure that the pre-terminated cable assemblies consist of fiber optic cables with factory-installed ST-type connectors on one end of the cable and an un-terminated optical fiber on the other. Ensure that the pre-terminated connector assemblies are installed with fusion splices. Ensure that all buffer tubes and fibers are protected once the attachment of pre-terminated connector assemblies is complete.

2.03.2 Buffer Tube Fan-out Kits. Ensure that a buffer tube fan-out kit is installed when fiber optic cables are terminated. Use a kit compatible with the fiber optic cable being terminated and that is color-coded to match the optical fiber color scheme. Ensure that the buffer tube fan-out kit supports 12 fiber strands. Ensure that output tubing and the fiber strands contained therein are of sufficient length for routing and attachment of fiber optic cable to connected electronics or as directed by the Engineer. Ensure that the kit and the connectors are supplied by the same manufacturer.

2.04 Patch Panels. Ensure that the patch panel is compatible with the fiber optic cable being terminated and color-coded to match the optical fiber color scheme. Ensure that the patch panel has a minimum of twelve ST-type panel connectors. Ensure that the patch panel does not exceed a 14 inches length by 6 inches width by 4 inch depth, and is suitable for mounting within an approved cabinet at the field device location.

2.04.1 Pre-terminated Patch Panels. Ensure that the pre-terminated patch panel is a termination panel that includes a factory installed all-dielectric SMF cable stub. Ensure that the panel includes factory-installed and terminated ST-type panel connectors. Ensure that the cable stub is of adequate length to splice the stub and provide a fiber connection between the panel and the backbone fiber cable or as directed by the Engineer.

2.04.2 Field Assembled and Terminated Patch Panels. Ensure that the field-assembled patch panel is a termination panel that includes a connector panel and the hardware required to mount the patch panel within an approved cabinet at the field device location and connect the panel to the backbone fiber cable.

2.04.2.1 Connector Panel. Ensure that the connector panel provides twelve ST-type, bulkhead-mount coupling connectors. Ensure that each coupling connector allows connection of a cable terminated on one side of the panel to a cable on the opposite side. Ensure that each bulkhead-mount coupling connector includes a locknut for mounting the connector in predrilled or punched holes in the connector panel.

2.05 Handling.

2.05.1 Cable End-Sealing. Ensure that fiber optic cable ends are capped or sealed to prevent the entry of moisture during shipping, handling, storage, and installation. Equip one end of the fiber optic cable with flexible pulling eyes.

2.05.2 Protective Wrap. Ensure that the fiber optic cable is shipped and stored with a protective wrap or other approved mechanical reel protection device over the outer turns of the fiber optic cable on each reel. Ensure that

the wrap is weather resistant and protects the cable reel from environmental hazards. Ensure that the cable reel remains wrapped until cable is to be installed.

2.05.3 Packaging, Shipping and Receiving. Ensure that the packaging and delivery of fiber optic cable reels comply with the following minimum requirements:

1. Ensure cable is shipped on reels of marked continuous length.
2. Ensure each cable is shipped on a separate, strongly constructed reel designed to prevent damage to the cable during shipment and installation.
3. Ensure each reel has a minimum of 6 feet on each end of the cable available for testing.
4. Ensure that all fiber optic cable is continuous and free from damage.
5. Ensure no point discontinuities greater than 0.1 decibel per reel.
6. Ensure that all cable delivered has been manufactured within 6 months of the delivery date.
7. Provide a copy of the transmission loss test results as required by the EIA/TIA-455-61 standard, as well as results from factory tests performed prior to shipping.
8. Ensure that the manufacturer provides the date of manufacture; product and serial numbers; cable data, including the reel length; refraction index; the project name and location; type of fiber and quantity of strands used; technical product data sheet(s); and reel number(s).

2.06 Aluminum Single Conductor. Provide moisture and head-resistant thermoplastic insulated electrical cable for single conductors rated at 600 V for installation in conduit and pipe. Wiring shall follow current NEC standards.

All criteria found under Section 711, New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Construction, excepting wire material, shall apply to installation.

3.0 INSTALLATION.

3.01 General. Install all equipment according to the latest version of the manufacturer's installation procedures and the industry-accepted installation standards, codes, and practices, or as directed by the Engineer. Ensure that all materials and installation practices are in accordance with the applicable OSHA requirements as found in 29 Code of Federal Regulations (CFR) Part 1926, Safety and Health Standards for Construction. In addition, perform the following:

1. Ensure conduit and inner-duct is clean and free from damage prior to installing fiber optic cable.
2. Document the sequential cable length markings at each splice box and pull box wall that the cable passes through, and include the information with the as-built documentation. Provide all incidental parts needed to complete the installation, but not specified in the plans, as necessary for a complete and properly operating system.

3.02 Fiber Optic Cable Installation. Develop a nomenclature plan for identification of fiber optic cable. Submit the nomenclature plan to the Engineer for approval. Use approved cable nomenclature to create cable tags for the identification of fiber optic cable. Provide cable tag identification on all test results or fiber related documents provided to the Engineer.

Install cable tags within 1 foot of each splice and/or termination point indicating the cable type, fiber count, and each fiber optic cable's origination and termination points. Ensure that the cable tags are permanent labels suitable for outside plant applications and are affixed to all fiber optic cables. Ensure that lettering is in permanent ink and displays the phrase "NMDOT FIBER OPTIC CABLE".

3.02.1 Pulling. Install the fiber optic cable by hand or by using a mechanical pulling machine. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter. Ensure that at no time the manufacturer's recommended maximum pulling tension is exceeded. Ensure that the central strength member and aramid yarn are attached directly to the pulling eye during cable pulling. Use pulling attachments, such as "basket grip" or "Chinese finger" type, to ensure that the optical and mechanical characteristics are not degraded during the fiber optic cable installation. Ensure that excess cable is coiled in a figure eight and fed manually when pulling through pull boxes and manholes by hand. If pulleys and sheaves will be used to mechanically pull through pull boxes and manholes, provide a drawing of the proposed layout showing that the cable will never be pulled through a radius less than the manufacturer's minimum bend radius. Use large diameter wheels, pulling sheaves, and cable guides to maintain the appropriate bend radius. Provide tension monitoring at all times during the pulling operation. Ensure that cable pulling lubricant used during installation is recommended by the optical fiber cable manufacturer.

3.02.2 Blowing. Use either the high-airspeed blowing (HASB) method or the piston method. When using the HASB method, ensure that the volume of air passing through the conduit does not exceed 600 cubic feet per minute or the conduit manufacturer's recommended air volume, whichever is more restrictive. When using the piston method, ensure that the volume of air passing through the conduit does not exceed 300 cubic feet per minute or the conduit manufacturer's recommended air volume, whichever is more restrictive.

3.02.3 Slack Cable Storage. Provide and store fiber optic cable at each pull box and manhole to allow for future splices, additions, or repairs to the fiber network. Store the fiber optic cable without twisting or bending the cable below the minimum bend radius. Store a 50 feet of fiber optic cable in manholes and an additional 20 ft at each splice, with 10 feet of cable on each side of the cable splice point or as shown in the plans. Store 25 feet of spare fiber optic cable in pull boxes.

3.03 Splicing. Perform all optical fiber splicing using the fusion splicing technique, and according to the latest version of the manufacturer's cable installation procedures; industry-accepted installation standards, codes, and practices; or as directed by the Engineer. Ensure that all splices match fiber and buffer tube colors unless shown otherwise in the plans. Where a fiber cable is to be accessed for lateral or drop signal insertion, only open the buffer tube containing the fiber to be accessed and only cut the actual fiber to be accessed. If a fiber end is not intended for use, cut the fiber to a length equal to that of the fiber to be used and neatly lay it into the splice tray. Treat any fibers exposed during splicing with a protective coating and place in a protective sleeve or housing to protect the fiber from damage or contaminants.

3.03.1 Splice Plan. Provide a splice plan showing the location and configuration of splices in the system for approval by the Engineer. Perform all splicing according to the plan. Document each splice location and identify the source and destination of each fiber in each splice tray. Document all fiber colors and buffer jacket colors used during installation, and develop a sequential fiber numbering plan as required in the TIA/EIA-598-A standard for color-coding in the documentation. Neatly store all splice enclosures within an ITS manhole. Attach the splice enclosure to the interior wall to prevent the enclosure from lying on the bottom of the manhole.

3.03.2 Splice Equipment Specifications: Use a fusion splice machine to splice all optical fiber. Ensure that the unit is portable, and capable of 120 VAC and internal battery-powered operation. Ensure that the unit is able to splice fibers with a 250-micrometer coating. The fusion splice machine shall have the following capabilities:

1. Splice loss measurement.
2. Splice protection sleeve heater.

3. Battery with charging unit and power cable.
4. Spare electrodes, fuses, and lamps.
5. Power meter/light source with carrying case.

Ensure that the power meter/light source is a calibrated pair that is portable and battery operated. Ensure that the power meter/light source operates at selectable wavelengths of 850/1,300/1,550 nanometers. Ensure that the power meter has a decibel milliwatt measurement scale with a range of +3 to -45 decibel milliwatts for SMF operation and an accuracy of 0.5 decibel or better. Ensure that the splice machine is new from the factory, or serviced and certified by the factory or its authorized representative within the previous 6 months from the commencement of its use. Provide the Engineer with a letter from the manufacturer or his authorized representative certifying compliance. Clean all splicing equipment and calibrate according to the manufacturer's recommendations prior to each splicing session at each location.

3.04 Cable Termination Installation. Ensure that cables, buffer tubes, or strands are neatly routed, secured and terminated in a patch panel. Ensure all cable termination points include documentation regarding the identification, route, and function of each fiber installed at that location. Ensure that at least one copy of this information is placed alongside the installed equipment (for instance, in a document pouch or drawer within a field cabinet).

3.05 Patch Panel Installation. Ensure that patch panels neatly installed and secured in a weather proof enclosure. Ensure all patch panel connectors are clearly and permanently labeled. Ensure all installed patch panels include documentation regarding the identification, route, and function of each patch panel connector at that location. Ensure that at least one copy of this information is placed alongside the installed equipment.

4.0 TESTING AND CERTIFICATION.

In addition to these requirements, the Contractor shall be required to demonstrate compliance with special provision "ITS System Acceptance Testing". Where there is a difference between the two requirements the more conservative requirement must be met.

4.01 Manufacturer's Testing. Provide documentation of all factory tests performed by the manufacturer for all fiber optic cable, splicing material, cable terminations, and patch panels.

4.02 Installation Testing. Notify the Engineer of cable testing at least 14 calendar days in advance. Provide the testing procedures to the Engineer for approval prior to commencement of testing. Perform all tests at 1,310/1,550 nanometer wavelengths, and include the last calibration date of all test equipment with the test parameters set on the equipment in the test documentation. Test all installed fibers (terminated and un-terminated) using methods approved by the Engineer.

4.02.1 End to End Attenuation Testing. Perform test on all fibers to ensure that no discontinuities greater than 0.2 decibel per 300 feet exist. Repair or replace cable sections exceeding allowable attenuation at no cost to the Department.

4.02.2 OTDR Tracing. Test all fibers from both cable end points with an optical time domain reflectometer (OTDR) at wavelengths of 1310 and 1550 nm. Test the fibers that are not terminated at the time of installation using a bare fiber adapter. Present the results of the OTDR testing (i.e., traces for each fiber) and a loss table showing details for each splice or termination tested to the Engineer in an approved electronic format. Ensure all OTDR testing complies with the EIA/TIA-455-61 standard.

4.02.3 Splice Loss Testing. Ensure that the splice loss for a SMF fusion splice does not exceed a maximum bidirectional average of 0.03 decibel per splice. Repair or replace splices that exceed allowable attenuation at no cost to the Department.

4.02.4 Connector Loss Testing. Ensure that the attenuation in the connector at each termination panel and its associated splice does not exceed 0.35 decibel. Repair or replace connectors exceeding allowable attenuation at no cost to the Department.

5.0 CONSTRUCTION REQUIREMENTS.

5.01 Conduit and Locate System. See special provisions for Multi-Duct Conduit System.

5.02 Pull Boxes and ITS Manhole for Fiber Optic Cable. See special provisions for "ITS Pull Box and Manhole".

6.0 Guaranty Provisions. Ensure that the fiber optic cable, the splice enclosures, and termination points, have a two-year manufacturer's warranty from the date of final acceptance by the Engineer. If the manufacturer's warranties for the components are for a longer period, those longer period warranties will apply.

Ensure that the manufacturer's warranties on the fiber optic cable, the splice enclosures, and termination points, are fully transferable from the Contractor to the Department. Ensure that these warranties require the manufacturer to furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department within 10 calendar days of notification by the Department.

7.0 Documentation. As built documentation on fiber location must be provided in both shape files: (i.e., GIS – latest version of type specified by the Engineer) and pdf files. Shape files to 1 ft. accuracy.

8.0 METHOD OF MEASUREMENTS.

8.01 Furnish and Install. Fiber optic cable shall be measured per foot of cable furnished, installed, warranted, tested and deemed fully operational. Splices and terminations as shown in the plans shall be measured per each fiber connection furnished and installed.

The Contract unit price, furnished and installed, will include furnishing, placement, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s) and firmware(s), supplies, support, personnel training (when specified), shop drawings, documentation, and incidentals necessary to complete the work.

8.02 Furnish. The Contract unit price per foot of fiber optic cable, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

8.03 Install. The Contract unit price per foot of fiber optic cable, installed, will include placement and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s) and firmware(s), supplies, support, personnel training (when specified), shop drawings, documentation, and incidentals necessary to complete the work.

9.0 BASIS OF PAYMENT

Payment shall be made on a Lump Sum basis in accordance with the itemized list of unit costs submitted for bid item 750000 – Intelligent Transportation System.

Pay Item	Pay Unit
1- ITS Fiber Optic Cable	Lin.Ft
2- ITS Fiber Optic Connection	Each
3- ITS Fiber Optic Connection Hardware	Lump Sum

NOTE: The Contractor shall make reference to the lump sum item, INTELLIGENT TRANSPORTATION SYSTEMS (ITS), and shall enter the unit cost and total amount bid for the above-described items in the table under the appropriate description.

- Fifty percent (50%) of the lump sum bid price for this item will be paid upon successful installation and completion of the approved on-site stand alone tests.
- Twenty percent (20%) of the bid price will be paid upon successful installation and completion of the approved TMC stand alone test

- Twenty percent (20%) of the bid price will be paid upon successful installation and integration and completion of the integrated system acceptance tests for all systems.

- Ten percent (10%) of the bid price will be paid upon successful completion of the 30 calendar day operational test period and delivery of GIS data.