

Florida Department of Transportation

RICK SCOTT GOVERNOR 605 Suwannee Street Tallahassee, FL 32399-0450 ANANTH PRASAD, P.E. SECRETARY

January 25, 2013

Monica Gourdine Program Operations Engineer Federal Highway Administration 545 John Knox Road, Suite 200 Tallahassee, Florida 32303

Re: Office of Design, Specifications

Section 783

Proposed Specification: 7830000 ITS - Fiber Optic Cable and Interconnect

Dear Ms. Gourdine:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Jeff Morgan of the State Traffic Engineering and Operations Office to delete Section 783. The content has been rolled into Sections 630, 635 and 633.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to SP965TT or trey.tillander@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4140.

Sincerely,

Signature on File

V. Y. "Trey" Tillander, III, P.E. State Specifications Engineer

TT/ft

Attachment

cc: Florida Transportation Builders' Assoc.

State Construction Engineer

INTELLIGENT TRANSPORTATION SYSTEMS – FIBER OPTIC CABLE AND INTERCONNECT.

(REV 11-20-12)

SECTION 783 (Pages 897 – 913) is deleted.

SECTION 783 INTELLIGENT TRANSPORTATION SYSTEMS FIBER OPTIC CABLE AND INTERCONNECT

783-1 Fiber Optic Cable System.

783-1.1 Description. Furnish and install a fiber optic cable system as shown in the Plans.

783-1.2 Materials:

783-1.2.1 Fiber Optic Cable: Provide all-dielectric, dry-filled, loose-tube, dispersion-unshifted, single-mode fiber (SMF) with low water peak, gel free, 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 dispersion-unshifted 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.

783-1.2.1.1 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, the U.S. Department of Agriculture Rural Utilities Service (RUS) 7-CFR 1755.900, and International Telecommunication Union ITU-T G.652.D requirements. Use only optical fibers meeting the additional requirements as follows:

| Geometry | |
|--|--|
| Cladding Diameter: 125μm, ±0.7 μm | |
| Core-to-Cladding Concentricity: ≤0.5 μm | |
| Cladding Noncircularity: ≤0.7% | |
| Mode Field Diameter: 1,550 nm; 10.4 μm, ±0.5 μm | |
| Coating Diameter: 245 μm, ±5 μm | |
| Colored Fiber Nominal Diameter: 250 ±15 μm | |
| Optical | |
| Cabled Fiber Attenuation: 1,310 nm, ≤0.4 dB/km; 1,550 nm, ≤0.3 dB/km | |
| Point Discontinuity: 1,310 nm, ≤0.05 dB/km; 1,550 nm, ≤0.05 dB/km | |
| Cable Cutoff Wavelength (λ_{ccf}): $\leq 1,260 \text{ nm}$. | |
| Total Dispersion: 1,625 nm ≤23.0 ps/(nm•km) | |

mm: ≤0.05 dB at 1.550 nm Cabled Polarization Mode Dispersion: <0.5 ps/\/km 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. 783-1.2.1.2 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. 783-1.2.1.3 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-B 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. 783-1.2.1.4 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 lbs, without damage to any components of the fiber optic cable. 783-1.2.1.5 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 water-blocking materials 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 waterblocking compound longitudinally around the outside of the central buffer tubes. Construct all cables with water-blocking material 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. 783-1.2.1.6 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. 783-1.2.1.7 Filler: Fillers or rods may be included in the cable core to lend symmetry to the cable cross section if required. 783-1.2.1.8 Outer Jacket: Ensure that the fiber optic cable is jacketed with medium density polyethylene (MDPE) that is free of blisters, cracks, holes,

Macrobend Attenuation: Turns 100; Outer diameter (OD) of the mandrel $60 \text{ mm}, \pm 2$

and other deformities. Ensure that the nominal jacket thickness is a minimum of 0.03 inches. Apply the jacketing material directly over the tensile strength members and water blocking material. Ensure that the MDPE contains carbon black to provide UV protection and does not promote the growth of fungus.

Mark the jacket with the cable manufacturer's name, fiber type, fiber count, date of manufacture, the words "FDOT 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.

783-1.2.1.9 Performance Requirements:

783-1.2.1.9.1 Operating Temperature: Ensure that the shipping and the operating temperature range of fiber optic cable meets or exceeds minus 30° to 158° F. Ensure that the installation temperature range of fiber optic cable meets or exceeds minus 22° to 140° F.

783-1.2.1.9.2 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.

783-1.2.1.9.3 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 inches to 0.8 inches 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.

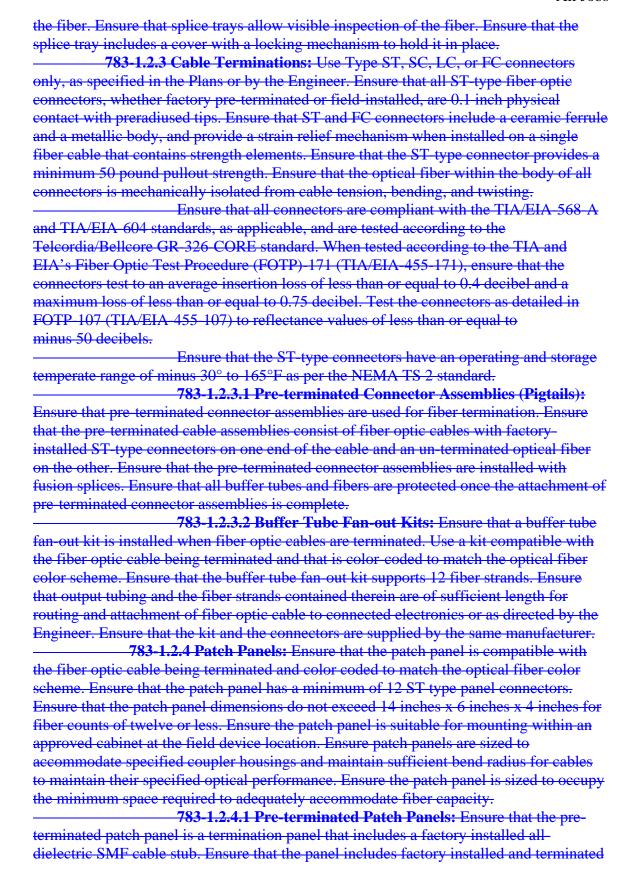
783-1.2.1.9.4 Water Penetration: Ensure that the fiber optic cable is capable of withstanding the tests for water penetration defined in the TIA/EIA 455-82 standard. Ensure that a one-meter length of cable is able to withstand a one-meter static head of water applied at one end for 24 hours without water leaking through the other open cable end.

783-1.2.2 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.

783-1.2.2.1 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

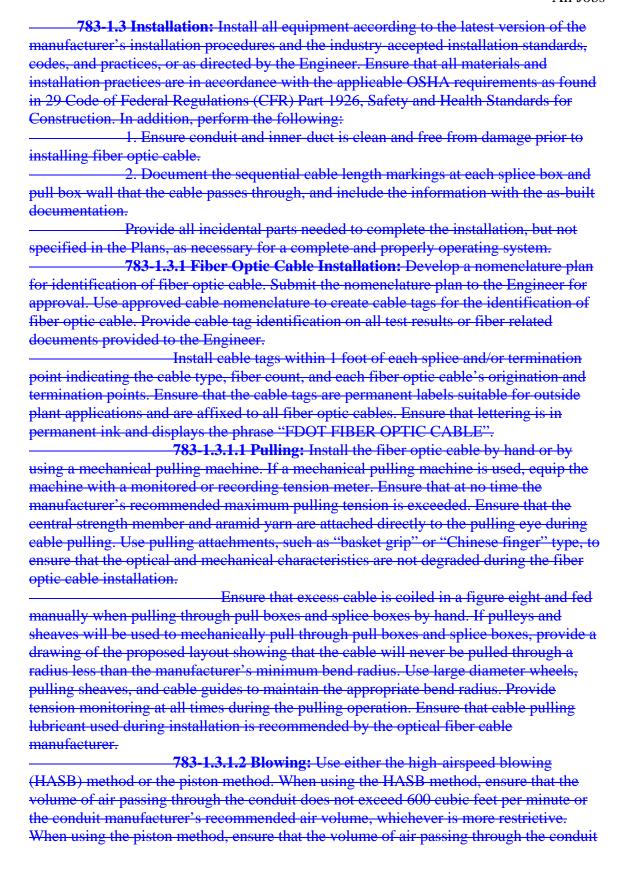
| opening in the cable, and organizes and stores optical fiber. Ensure all hinges and |
|---|
| latching devices are stainless steel. Ensure that the enclosure is airtight and prevents |
| water intrusion. Ensure that the splice enclosure can accommodate pressurization and has |
| the ability to be reentered 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 outside diameters ranging from 0.45 inches to |
| 0.55 inches, plus 10%, without jeopardizing the waterproof characteristics of the |
| enclosure. |
| Provide fiber optic splice enclosures meeting the following |
| requirements: |
| Mechanical 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 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. |
| |
| 792 1 2 2 2 Caller Transaction (1 at the caller transaction) |

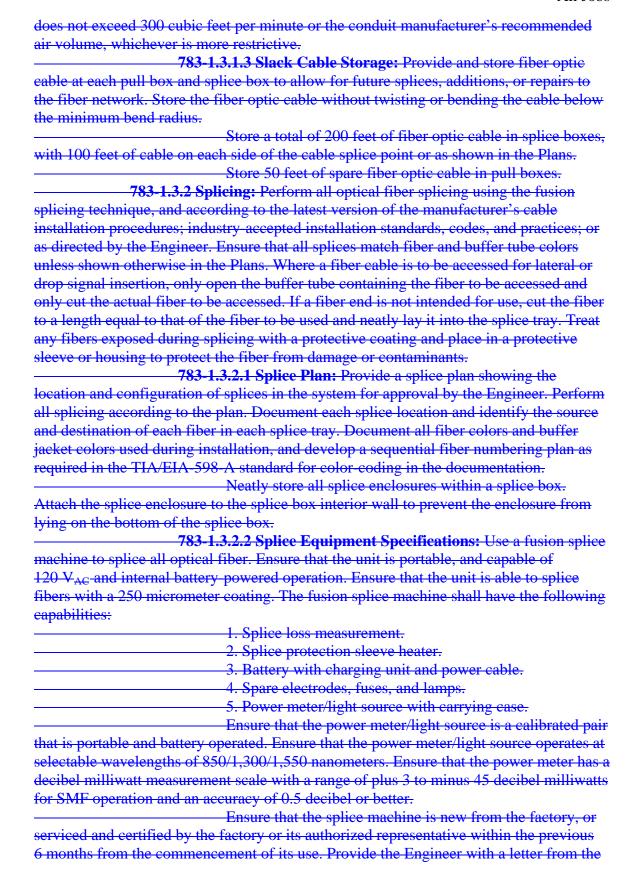
783-1.2.2.2 Splice Trays: Ensure that the splice trays are securely attached and accessible, and provide adequate storage for the fiber cable. Ensure the splice trays provide access to individual fibers without disrupting other fibers in the tray. Ensure that the splice trays hold the buffer tubes rigidly in place and provide protection for fusion splices. Ensure that the raceway accommodates the minimum bend radius of



stub and provide a fiber connection between the panel and the backbone fiber cable or as directed by the Engineer. 783-1.2.4.2 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. 783-1.2.4.2.1 Connector Panel: Ensure that the connector panel provides 12 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. 783-1.2.5 **Handling:** 783-1.2.5.1 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. 783-1.2.5.2 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. 783-1.2.5.3 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 sheets; and reel numbers.

ST type panel connectors. Ensure that the cable stub is of adequate length to splice 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.

783-1.3.3 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).

783-1.3.4 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.

783-1.4 Testing and Certification:

783-1.4.1 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.

783-1.4.2 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.

783-1.4.2.1 End to End Attenuation Testing: Perform testing on all fibers to ensure that end to end attenuation does not exceed allowable loss (0.4 db/km for 1310nm wavelength, 0.3 db/km for 1550nm wavelength, plus 0.5 db for any connectors and 0.1 db for splices). Repair or replace cable sections exceeding allowable attenuation at no cost to the Department.

783-1.4.2.2 OTDR Tracing: Test all fibers from both cable end points with an optical time domain reflectometer (OTDR) at wavelengths of 1310 and 1550nm. 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.

783-1.4.2.3 Splice Loss Testing: Ensure that the splice loss for a SMF fusion splice does not exceed a maximum bidirectional average of 0.1 decibel per splice. Repair or replace splices that exceed allowable attenuation at no cost to the Department.

783-1.4.2.4 Connector Loss Testing: Ensure that the attenuation in the connector at each termination panel and its associated splice does not exceed 0.5 decibel. Repair or replace connectors exceeding allowable attenuation at no cost to the Department.

783-2 Conduit and Locate System. 783-2.1 General: Furnish and install conduit and a locate system for fiber optic cable. Ensure that the conduit complies with the requirements of Section 630. Place the locate system along any underground conduit installation. Ensure that the locate system includes aboveground route markers, warning tape, tone wire, and electronics that allow detection of buried conduit and other related underground facilities. Furnish and install a system as shown in the Plans and as directed by the **Engineer.** Ensure that the locate system provides: 1. An end-to-end electrical conductor, such as a locate wire, buried along the conduit system for conductive facility locating. 2. Visual notification of the presence of conduit installed on Department projects. 3. Public notification of potential hazards and contact information for public or private inquiries regarding the conduit system. 4. A means of locating any conduit system pull box or splice box that is buried. 5. Surge protection and dissipation of transient voltages that may be induced into the route marker system. **783-2.2 Materials:** 783-2.2.1 Route Markers: Mark the location of the conduit system with rigid sign posts known as route markers. Use route markers of the type shown in the Plans and approved by the Engineer. Route markers may be either a Standard Route Marker (SRM) type or an Electronic Route Marker (ERM) type. The SRM is a rigid, tubular, driven post used for location and notification purposes only. The ERM should be physically identical to the SRM, but also include a termination board to provide aboveground access to locate wire buried alongside conduit and cable runs. Ensure that each SRM is labeled and identified as an FDOT fiber optic cable marker as shown in the Plans and approved by the Engineer. Ensure that labels include the Department's logo, contact information for the local FDOT District, and a telephone number to call prior to any excavation in the area. Ensure that the identification information is permanently imprinted on the top fitting, and will not peel, fade, or deteriorate with prolonged exposure to the typical roadside environmental hazards. Ensure that all route markers used on the project are new and consistent in appearance. 783-2.2.1.1 Standard Route Marker: Ensure that the SRM post is white with a top fitting cover that is orange with white lettering and graphics. Ensure that the SRM is a tubular configuration, and both the marker post and the top fitting are made from virgin Type 111 high-density polyethylene (HDPE). Ensure that any fasteners used with the SRM are constructed of stainless steel. Ensure that all SRMs have a minimum outside diameter of 3.5 inches with a minimum 0.125 inch wall thickness. Ensure that the top fitting cover is a minimum of 1.5 feet long and has an outside diameter of 3.75 inches with a 0.125 inch wall thickness. Ensure that each SRM provides a tensile strength of 4,200 pounds per

square inch as required in the ASTM D638 standard. Ensure that each SRM is

manufactured for use in temperatures range of minus 30° to 165°F as per the NEMA TS 2 standard Ensure that each SRM can withstand 70 foot pounds of impact force at 32°F as required in the ASTM D2444 standard before and after UV conditioning for 2,000 hours as required in the ASTM G53-88 standard. Ensure that the control sample of any material employed maintains a minimum of 70% of its original tensile strength as required by the ASTM D638 standard. Ensure that an SRM installed at the minimum 2 foot depth withstands at least one vehicle impact at 45 miles per hour by a car or truck weighing no less than 3,500 pounds. After impact, ensure that the post returns to an upright position within 10 degrees of vertical alignment within 30 seconds from the time of impact. Ensure that all SRMs withstand a 12-gauge shotgun blast without penetration by any pellets when fired from a 50 foot distance. 783-2.2.1.2 Electronic Route Marker: Ensure that the ERMs meet the same material and performance requirements as the SRMs with the following exceptions. Equip each ERM with a removable, top-fitting cover that is black with white lettering. Ensure that each ERM contains a terminal board equipped with locate wire and ground connectors. Ensure that the terminal board is made from corrosionresistant materials and includes terminal facilities labeled according to function. Ensure the terminal board includes uniform spacing between connection points. 783-2.2.2 Warning Tape: Ensure that the buried cable warning tape is flexible, elastic material 3 inches wide and 6 mil thick, intended for burial and use as an underground utility warning notice. Ensure that the surface of the warning tape is coated and sealed to prevent deterioration caused by harsh soil elements. Ensure that the tape material and ink colors do not change when exposed to acids, alkalis, and other destructive chemical variances commonly found in Florida soils. Ensure that the warning tape color is orange as required by the American Public Works Association (APWA) Uniform Color Code, and has "CAUTION: FDOT FIBER OPTIC CABLE BURIED BELOW," or other wording approved by the Engineer, permanently printed on its surface. Include buried cable warning tape with all conduit. 783-2.2.3 Locate Wire: Ensure that the locate wire and locate wire splices comply with Section 630. 783-2.2.3.1 Locate Wire Surge Protection: Furnish and install a locate wire surge protection system as shown in the Plans or directed by the Engineer. Ensure that locate wires are attached to a surge protection system dedicated to safely dissipating high transient voltages or other foreign electrical surges induced into the designating system. Provide this grounding through a stand-alone system that does not include electric power or ITS device grounding. Ensure that the surge protection system allows signals generated by locate system transmitters to pass through the protection system without going to ground. Ensure that the protection system automatically resets and passes locate system transmitter signals after the unit has grounded to dissipate overvoltages. Ensure that the locate wire surge protection is intended for below- or abovegrade applications. Ensure that the locate wire surge protection system is grounded to a

driven rod within 10 feet of the system using a AWG #6 single conductor wire with green

insulation. Ensure that the locate wire surge protection is enclosed for protection from environmental hazards and accessible for connection of portable locate system transmitters.

Ensure that the locate wire surge protection system meets the following minimum standards for surge protection:

| Surge Element | 3-element maximum duty fail-safe gas tube. |
|-----------------|---|
| Rating | 40,000 A surge capacity (single-cycle, 8 by 20 microsecond |
| | waveform). |
| Life | Minimum 1,000 surges (1000 A to ground). |
| Fail-Safe | Integral fail-shorted device. |
| Insulation | 1,000 megohm minimum at 100 volts of direct current (V _{DC}). |
| Resistance | |
| Clamp Voltages | a. Impulse at 100 Volts per Microsecond: Typically 500 volts. |
| | b. Direct Current: 300 to 500 volts. |

783-2.2.4 Locate System Electronic Equipment: Provide locate system electronic equipment that is designed specifically for locating buried pipes and cables. Ensure that the locate system electronic equipment is able to detect the location and depth of the locate wire buried alongside conduit and cable runs. Ensure that the locate system electronic equipment is capable of locating faults in the sheath of a buried locate wire. Ensure that locate system electronic equipment is provided with protective cases suitable for daily transport and storage of transmitters and receivers. Ensure that the locate system electronic equipment includes a transmitter, receiver, and electronic box markers as shown in the Plans and approved by the Engineer.

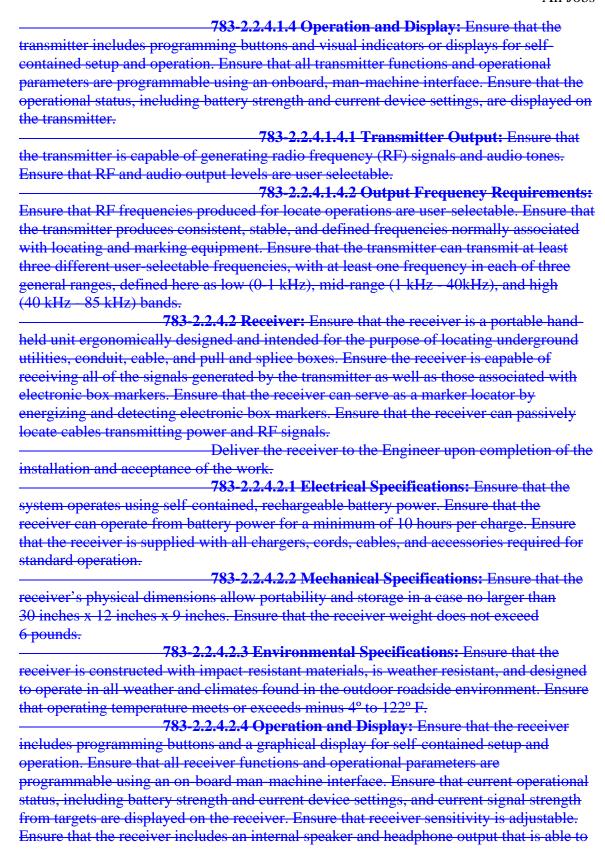
783-2.2.4.1 Transmitter: Ensure that the transmitter is a portable unit designed to create and apply an identifiable signal onto a locate wire so that it can be located and traced with a receiver. Ensure the transmitter is capable of applying a trace signal using direct connection and inductive methods. Ensure that the transmitter output circuitry is protected against inadvertent connection to conductors carrying voltages up to 250V at 50/60Hz.

Deliver the transmitter to the Engineer upon completion of the installation and acceptance of the work.

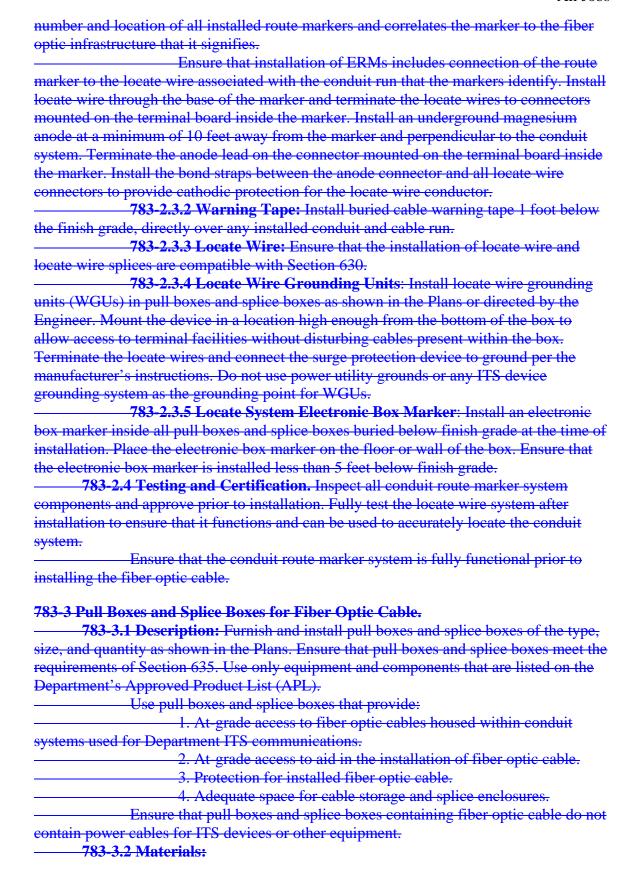
783-2.2.4.1.1 Electrical Specifications: Ensure that the system operates using 120 V_{AC} input power as well as self-contained, rechargeable battery power. Ensure that the transmitter can operate from battery power for a minimum of 10 hours per charge. Ensure that the transmitter is supplied with all chargers, cords, cables, and accessories required for standard operation.

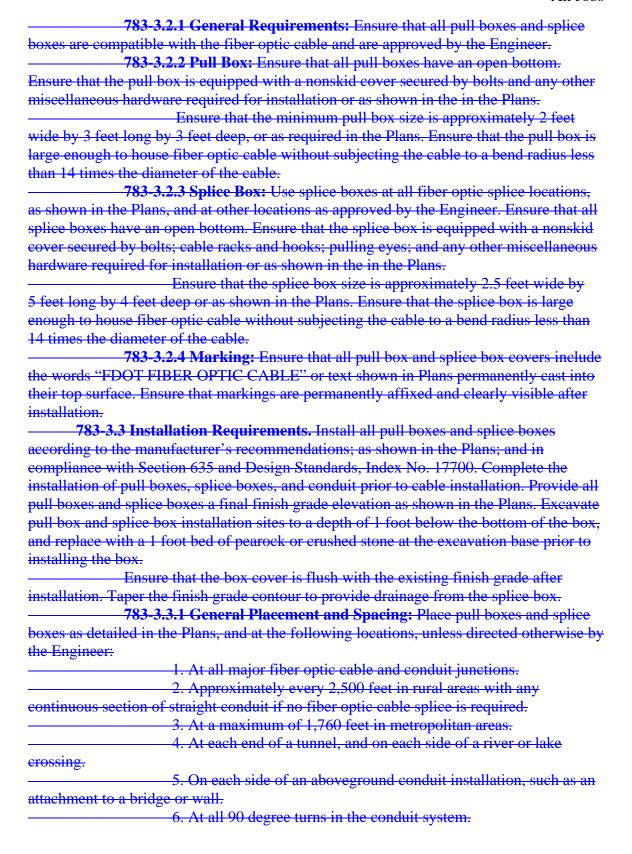
783-2.2.4.1.2 Mechanical Specifications: Ensure that the transmitter's physical dimensions allow portability and storage in a case no larger than 16 inches x 12 inches x 5 inches. Ensure that the transmitter weight does not exceed 10 pounds.

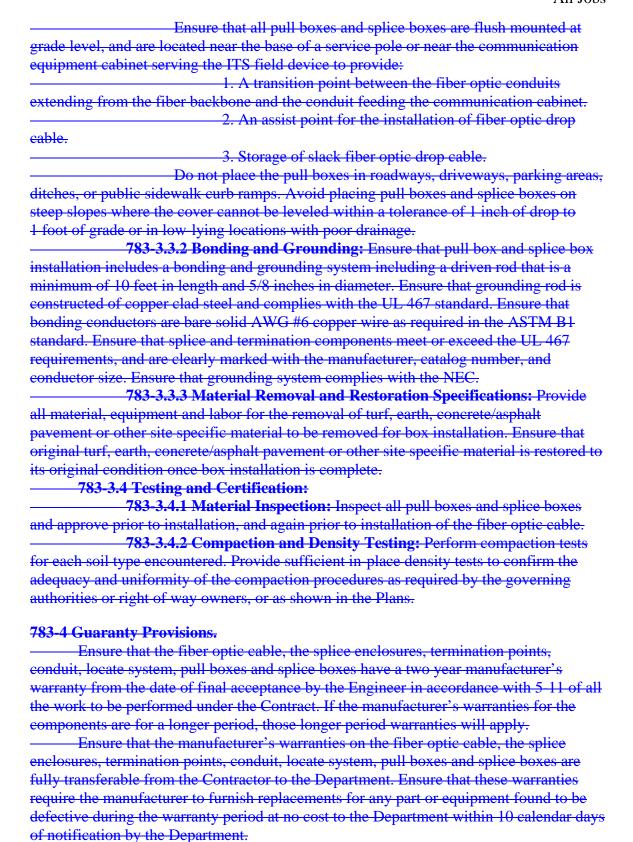
783-2.2.4.1.3 Environmental Specifications: Ensure that the transmitter is constructed with impact-resistant materials, is weather resistant, and designed to operate unattended in all weather and climates found in the outdoor roadside environment. Ensure that operating temperature meets or exceeds minus 4° to 122° F.



provide audible tones that indicate received signal strength. Ensure audible outputs include on/off and volume control. Ensure that the receiver is capable of locating buried locate wire and electronic box markers within plus or minus 5% of actual depth. Ensure that the receiver can detect the center line of a target locate wire within 3 inches of its actual location. 783-2.2.4.3 Electronic Box Marker: Equip all pull boxes and splice boxes buried below finish grade with an electronic box marker inside the pull box or splice box to mark the location. Ensure that the electronic box marker is a device specifically manufactured to electronically mark and locate underground facilities. Ensure that the electronic box marker includes circuitry and an antenna encased in a waterproof polyethylene shell. Ensure that the outer shell is impervious to minerals, chemicals, and temperature extremes normally found in underground plant environments. Ensure that the electronic box marker does not require any batteries or active components to operate. Ensure that electronic box markers used to mark fiber optic cable and general telecom applications are orange in color and operate at 101.4 kHz. When excited by a marker locator, ensure that the electronic box marker's passive circuits produce an RF field to direct the marker locator to its position. Ensure that the electronic box marker has a minimum operating range of 5 feet from the marker locator. **783-2.3 Installation Requirements:** 783-2.3.1 Route Markers: Install route markers as shown in the Plans and as directed by the Engineer. Ensure that route markers are plumb and level with the notification information clearly visible when viewed from the side facing the roadway. Place route markers at a 1 foot offset from the conduit system or as shown in the Plans. Ensure that markers are set within the right-of-way. Set the route markers concurrently with the conduit system installation and prior to the fiber cable installation. Install route markers of the type as shown in the Plans and as follows: 1. 1. So that a clear line of sight is maintained from one marker to the next. 2. A maximum distance apart of 500 feet. 3. On both sides of the road at any crossing point where the conduit system changes to the opposite side of the road. 4. At the center point of any conduit run between two pull or splice boxes. 5. At gate locations when the conduit system is adjacent to a fence line. 6. On both sides of a stream, river, or other water crossing. 7. On both sides of aboveground attachments, such as bridges and walls. Remove and replace all marker posts damaged during installation at no additional cost. Ensure that the top of the marker post is a minimum of 5 feet and no more than 6 feet above the finish grade. Ensure that route marker signs are labeled with a unique identification number, as detailed in the Plans or as approved by the Engineer. Provide as built documentation at the completion of installation that includes identification







783-5 Method of Measurement.

783-5.1 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 conduit and locate system shall be measured for payment per foot of conduit, buried cable warning tape and locate wire furnished, installed; designated with standard or electronic route markers (SRM or ERM), grounded, and protected. The conduit and locate system shall be warranted, made fully operational, and tested according to this specification.

The locate system electronic equipment (transmitters and receivers) shall be measured as each is delivered to the Engineer upon completion of the installation and acceptance of the work. Electronic box markers shall be measured as each is furnished, installed, and tested. The locate system electronic equipment shall be warranted, made fully operational, and tested according to this specification.

The fiber optic pull boxes and splice boxes shall be measured as each is furnished and installed, with grounding and associated hardware as detailed in the Plans.

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 packages and firmwares, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

783-5.2 Furnish: The Contract unit price per foot of fiber optic cable, conduit, or locate wire and route markers (SRM or ERM); each locate system transmitter, receiver, or electronic box marker; and each pull box or splice box, 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.

783-5.3 Install: The Contract unit price per foot of fiber optic cable, conduit, or locate wire and route markers (SRM or ERM); each electronic box marker; and each pull box or splice box, installed, will include placement and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages and firmwares, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.

783-6 Basis of Payment.

Prices and payments will be full compensation for all work described herein or shown in the Plans.

Payment will be made under:

| Item No. 783- 1- | ITS Fiber Optic Cable-per foot. |
|------------------|--|
| Item No. 783-2- | ITS Fiber Optic Connection-each. |
| Item No. 783-3- | ITS Fiber Optic Connection Hardware. |
| Item No. 783-4 | ITS Conduit per foot. |
| Item No. 783 5 | ITS Pull Box for Fiber Optic each. |
| Item No. 783- 6- | ITS Splice Box for Fiber Optic - each. |
| Item No. 783-9- | ITS Locate System Electronic Equipment - each. |

INTELLIGENT TRANSPORTATION SYSTEMS – FIBER OPTIC CABLE AND INTERCONNECT.

(REV 11-20-12)

SECTION 783 (Pages 897 – 913) is deleted.