Florida Department of Transportation

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February 1, 2008

Dr. Leslie McCarthy, PhD, P.E.
Program Operations Engineer
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: Office of Design, Specifications
Section 783
Proposed Specification: 7830202 ITS Conduit and Locate System - Materials

Dear Dr. McCarthy:

We are submitting, for your approval, two copies of a proposed Supplemental Specification for ITS Conduit and Locate System - Materials.

This change was proposed by Gene Glotzbach of the State ITS Office to clarify the provision of and payment for locate system electronic equipment.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via Email to SP965DB or duane.brautigam@dot.state.fl.us.

If you have any questions relating to this specification change, please call Duane F. Brautigam, State Specifications Engineer at 414-4110.

Sincerely,

Duane F. Brautigam, P.E.
State Specifications Engineer

DFB/ft
Attachment
cc: Gregory Jones, General Counsel
Florida Transportation Builders' Assoc.
State Construction Engineer

INTELLIGENT TRANSPORTATION SYSTEMS-FIBER OPTIC CABLE AND INTERCONNECT.

(REV ~~112-15~~ ~~9~~ ~~06~~*71-2-08~~1~~*1-28-08*) ~~(FA 1-29-07) (7-07)~~**

SUBARTICLE 783-2.2 (of the Supplemental Specifications) is deleted and the following substituted:

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 ~~appear identical to the casual observer~~*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 OD of 3.5 inches with a *minimum* 0.125-inch wall thickness~~ and a minimum 10-foot length~~. Ensure that the top fitting cover is a minimum of 1.5 feet long and has an OD 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 -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 percent 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 corrosion-resistant 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, 6 mil thick, intended for burial and use as a 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 normally 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 over-voltages. Ensure that the locate wire surge protection is intended for below- or above-grade 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 Resistance	1,000 megohm minimum at 100 volts of direct current (V_{DC}).
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 $120V_{AC}$ 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 -4º to 122º F.

783-2.2.4.1.4 Operation and Display: Ensure that the transmitter includes programming buttons and visual indicators or displays for self-contained setup and operation. Ensure that all transmitter functions and operational parameters are programmable using an onboard, man-machine interface. Ensure that the operational status, including battery strength and current device settings, are displayed on the transmitter.

783-2.2.4.1.4.1 Transmitter Output: Ensure that the transmitter is capable of generating radio frequency (RF) signals and audio tones. Ensure that RF and audio output levels are user selectable.

783-2.2.4.1.4.1 Output Frequency Requirements: Ensure that RF frequencies produced for locate operations are user-selectable. Ensure that the transmitter produces consistent, stable, and defined frequencies normally associated with locating and marking equipment. Ensure that the transmitter can transmit at least three different user-selectable frequencies, with at least one frequency in each of three general ranges, defined here as low (0-1 kHz), mid-range (1 kHz – 40 kHz), and high (40 kHz – 85 kHz) bands.

783-2.2.4.2 Receiver: Ensure that the receiver is a portable hand-held unit ergonomically designed and intended for the purpose of locating underground utilities, conduit, cable, and ~~electronic markers~~*pull and splice boxes*. Ensure the receiver is capable of receiving all of the signals generated by the transmitter as well as those associated with electronic *box*

markers. Ensure that the receiver can serve as a marker locator by energizing and detecting electronic *box* markers. Ensure that the receiver can passively locate cables transmitting power and RF signals.

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

783-2.2.4.2.1 Electrical Specifications: Ensure that the system operates using self-contained, rechargeable battery power. Ensure that the receiver can operate from battery power for a minimum of 10 hours per charge. Ensure that the receiver is supplied with all chargers, cords, cables, and accessories required for standard operation.

783-2.2.4.2.2 Mechanical Specifications: Ensure that the receiver's physical dimensions allow portability and storage in a case no larger than 30 inches x 12 inches x 9 inches. Ensure that the receiver weight does not exceed 6 pounds.

783-2.2.4.2.3 Environmental Specifications: Ensure that the receiver is constructed with impact-resistant materials, is weather resistant, and designed to operate in all weather and climates found in the outdoor roadside environment. Ensure that operating temperature meets or exceeds -4º to 122º F.

783-2.2.4.2.4 Operation and Display: Ensure that the receiver includes programming buttons and a graphical display for self-contained setup and operation. Ensure that all receiver functions and operational parameters are programmable using an on-board man-machine interface. Ensure that current operational status, including battery strength and current device settings, and current signal strength from targets are displayed on the receiver. Ensure that receiver sensitivity is adjustable. Ensure that the receiver includes an internal speaker and headphone output that is able to 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 ±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. So that a ~~person standing at a marker can see both neighboring markers.~~*clear line of site 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. ~~Excavate and install the bottom of the marker post to a depth of 4 feet, unless rock or other subsurface obstacles occur, in which case the steel post may be installed to a minimum depth of 2 feet with a concrete slurry backfill of 6 inches around the post. In either case, e~~*E*nsure 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 number and location of all installed route markers and correlates the marker to the fiber optic infrastructure that it signifies.

Ensure that installation of ERMs includes connection of the route marker to the locate wire associated with the conduit run that the markers identify. Install locate wire through the base of the marker and terminate the locate wires to connectors mounted on the terminal board inside the marker. Install an underground magnesium anode at a minimum of 10 feet away from the marker and perpendicular to the conduit system. Terminate the anode lead on the connector mounted on the terminal board inside the marker. Install the bond straps between the anode connector and all locate wire connectors to provide cathodic protection for the locate wire conductor.

783-2.3.2 Warning Tape: Install buried cable warning tape 1 foot below the finish grade, directly over any installed conduit and cable run.

783-2.3.3 Locate Wire: Ensure that the installation of locate wire and locate wire splices are compatible with Section 630.

783-2.3.4 Locate Wire Grounding Units: Install locate wire grounding units (WGUs) in pull boxes and splice boxes as shown in the plans or directed by the Engineer. Mount the device in a location high enough from the bottom of the box to allow access to terminal facilities without disturbing cables present within the box. Terminate the locate wires and connect the surge protection device to ground per the manufacturer’s instructions. Do not use power utility ground(s) or any ITS device grounding system as the grounding point for WGUs.

783-2.3.5 Locate System Electronic *Box* Marker: Install an electronic *box* marker inside all pull boxes and splice boxes buried below finish grade at the time of installation.

Place the electronic *box* marker on the floor or wall of the box. Ensure that the electronic *box* marker is installed less than 5 feet below finish grade.

783-2.4 Testing and Certification. Inspect all conduit route marker system components and approve prior to installation. Fully test the locate wire system after installation to ensure that it functions and can be used to accurately locate the conduit system.

Ensure that the conduit route marker system is fully functional prior to installing the fiber optic cable.

ARTICLE 783-5 (of the Supplemental Specifications) is deleted and the following substituted:

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 package(s) and firmware(s), 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 package(s) and firmware(s), 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 1-28-08)

SUBARTICLE 783-2.2 (of the Supplemental Specifications) is deleted and the following substituted:

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 OD 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 OD 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 -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 percent 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 corrosion-resistant 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, 6 mil thick, intended for burial and use as a 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 normally 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 over-voltages. Ensure that the locate wire surge protection is intended for below- or above-grade 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 Resistance	1,000 megohm minimum at 100 volts of direct current (V_{DC}).
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 $120V_{AC}$ 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 -4º to 122º F.

783-2.2.4.1.4 Operation and Display: Ensure that the transmitter includes programming buttons and visual indicators or displays for self-contained setup and operation. Ensure that all transmitter functions and operational parameters are programmable using an onboard, man-machine interface. Ensure that the operational status, including battery strength and current device settings, are displayed on the transmitter.

783-2.2.4.1.4.1 Transmitter Output: Ensure that the transmitter is capable of generating radio frequency (RF) signals and audio tones. Ensure that RF and audio output levels are user selectable.

783-2.2.4.1.4.1 Output Frequency Requirements: Ensure that RF frequencies produced for locate operations are user-selectable. Ensure that the transmitter produces consistent, stable, and defined frequencies normally associated with locating and marking equipment. Ensure that the transmitter can transmit at least three different user-selectable frequencies, with at least one frequency in each of three general ranges, defined here as low (0-1 kHz), mid-range (1 kHz – 40 kHz), and high (40 kHz – 85 kHz) bands.

783-2.2.4.2 Receiver: Ensure that the receiver is a portable hand-held unit ergonomically designed and intended for the purpose of locating underground utilities, conduit, cable, and pull and splice boxes. Ensure the receiver is capable of receiving all of the signals generated by the transmitter as well as those associated with electronic box markers. Ensure that the receiver can serve as a marker locator by energizing and detecting electronic box markers. Ensure that the receiver can passively locate cables transmitting power and RF signals.

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

783-2.2.4.2.1 Electrical Specifications: Ensure that the system operates using self-contained, rechargeable battery power. Ensure that the receiver can operate from battery power for a minimum of 10 hours per charge. Ensure that the receiver is supplied with all chargers, cords, cables, and accessories required for standard operation.

783-2.2.4.2.2 Mechanical Specifications: Ensure that the receiver's physical dimensions allow portability and storage in a case no larger than 30 inches x 12 inches x 9 inches. Ensure that the receiver weight does not exceed 6 pounds.

783-2.2.4.2.3 Environmental Specifications: Ensure that the receiver is constructed with impact-resistant materials, is weather resistant, and designed to operate in all weather and climates found in the outdoor roadside environment. Ensure that operating temperature meets or exceeds -4º to 122º F.

783-2.2.4.2.4 Operation and Display: Ensure that the receiver includes programming buttons and a graphical display for self-contained setup and operation. Ensure that all receiver functions and operational parameters are programmable using an on-board man-machine interface. Ensure that current operational status, including battery strength and current device settings, and current signal strength from targets are displayed on the receiver. Ensure that receiver sensitivity is adjustable. Ensure that the receiver includes an internal speaker and headphone output that is able to 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 ±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. So that a clear line of site 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 number and location of all installed route markers and correlates the marker to the fiber optic infrastructure that it signifies.

Ensure that installation of ERMs includes connection of the route marker to the locate wire associated with the conduit run that the markers identify. Install locate wire through the base of the marker and terminate the locate wires to connectors mounted on the terminal board inside the marker. Install an underground magnesium anode at a minimum of 10 feet away from the marker and perpendicular to the conduit system. Terminate the anode lead on the connector mounted on the terminal board inside the marker. Install the bond straps between the anode connector and all locate wire connectors to provide cathodic protection for the locate wire conductor.

783-2.3.2 Warning Tape: Install buried cable warning tape 1 foot below the finish grade, directly over any installed conduit and cable run.

783-2.3.3 Locate Wire: Ensure that the installation of locate wire and locate wire splices are compatible with Section 630.

783-2.3.4 Locate Wire Grounding Units: Install locate wire grounding units (WGUs) in pull boxes and splice boxes as shown in the plans or directed by the Engineer. Mount the device in a location high enough from the bottom of the box to allow access to terminal facilities without disturbing cables present within the box. Terminate the locate wires and connect the surge protection device to ground per the manufacturer’s instructions. Do not use power utility ground(s) or any ITS device grounding system as the grounding point for WGUs.

783-2.3.5 Locate System Electronic Box Marker: Install an electronic box marker inside all pull boxes and splice boxes buried below finish grade at the time of installation. Place the electronic box marker on the floor or wall of the box. Ensure that the electronic box marker is installed less than 5 feet below finish grade.

783-2.4 Testing and Certification. Inspect all conduit route marker system components and approve prior to installation. Fully test the locate wire system after installation to ensure that it functions and can be used to accurately locate the conduit system.

Ensure that the conduit route marker system is fully functional prior to installing the fiber optic cable.

ARTICLE 783-5 (of the Supplemental Specifications) is deleted and the following substituted:

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 package(s) and firmware(s), 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 package(s) and firmware(s), 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.

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783 Items