**REVISION OF SECTION 614**

FIBER OPTIC CABLE (SINGLE MODE)

**Section 614 of the Standard Specifications is hereby revised for this project to include the following:**

## DESCRIPTION

This work consists of furnishing, and placing single mode fiber optic cable at the locations shown on the plans.

## MATERIALS

**Fiber Optic Cable:** Fiber optic cable shall be loose tube non-armored outdoor cable consisting of single-mode fibers. Fiber optic cable shall be used for the main backbone cable, and lateral cables that connect the main cable to individual field equipment cabinets. This project item shall consist of 12 Strand Cable. Fiber optic cable shall be provided in reel lengths that eliminate cable end splicing.

All fiber optic cable provided by the Contractor shall be compatible with all materials purchase for the project.

All fiber optic cable shall be suitable for conduit installation and comply with this specification. Odd length cables and reel ends are acceptable for lateral cables provided that they are of sufficient length to connect from the main backbone cable to the equipment controller cabinets in continuous runs.

For the purposes of these Special Provisions, the term Secondary Market is used to reference the purchase of unused, stockpiled materials purchased for another project.

Materials purchased from the Secondary Marketmay be provided as approved by the Engineer. The materials shall meet all the requirements of new material including the material specifications within this Special Provision. The Engineer shall be notified of the Contractor’s intent to purchase the material from the Secondary Market no later than the Pre-construction Conference. As part of that notification, the Contractor shall provide an affidavit of ability to provide Certificates of Compliance and certified test reports from the potential supplier. The purchase of such materials shall not take place until the Contractor receives written approval from the Engineer. Certified test reports and Certificates of Compliance shall be submitted upon delivery of the materials.

**(a) General**

1. The fiber optic cable shall be an accepted product of the United States Department of Agriculture Rural Electrification Administration (REA) as meeting requirements of 7CFR1755.900
2. All optical cables shall meet all fiber optic standards and specifications of the

 International Municipal Signal Association (IMSA).

1. All optical cables shall meet all fiber optic standards, specifications and testing procedures as specified by EIA/TIA.
2. The cable shall be new, unused and of current design and manufacture.

**-2-**

### REVISION OF SECTION 614

FIBER OPTIC CABLE (SINGLE MODE)

1. All Fiber and Fiber installation shall be compliant with N.E.C. regulations.

 **(b) Fiber Characteristics**

1. All optical fibers must be usable fibers and shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this Special Provision.
2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.
3. The dispersion unshifted single-mode fiber utilized in the cable specified herein shall conform to the following specifications.
* Typical Core Diameter: 8.3 µm.
* Cladding Diameter: 125.0 ± 1.0 µm.
* Core-to-Cladding Offset: ≤ 0.6 µm.
* Cladding Non-Circularity: ≤ 1.0%.
	+ - * Defined as: [1-(min. Cladding dia. ÷ max. Cladding dia.)] X 100
* Coating Diameter: 245 ± 10 µm.
* Colored Fiber Diameter: nominal 250 µm.
* Attenuation Uniformity - No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.
* Attenuation at the Water Peak - The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.
* Cutoff Wavelength – The cabled fiber cutoff wavelength (λccf) shall be < 1260 nm.
* Mode-Field Diameter
	+ - * 9.30 ± 0.50 µm at 1310 nm
			* 10.50 ± 1.00 µm at 1550 nm
* Zero Dispersion Wavelength (λo): 1301.5 nm ≤ (λo) ≤ 1321.5 nm.
* Zero Dispersion Slope (So)- ≤ 0.092 ps ÷ (nm2•km)
* Fiber Polarization Mode Dispersion (PMD): 0.5 ps ÷ √km
* Fiber Curl: ≥ 4.0 m radius of curvature

**(c) Fiber Specification Parameters**

1. Required Fiber Grade - Maximum Individual Fiber Attenuation
2. The maximum dispersion for single-mode optical fibers shall be ≤ 3.2 ps/(nm•km) for 1285 nm through 1330 nm and shall be < 18 ps/(nm • km) at 1550 nm.
3. All optical fibers shall be proof tested by the manufacturer to a minimum load of 0.7 GN/m2 (100 ksi).

### -3-

### REVISION OF SECTION 614

FIBER OPTIC CABLE (SINGLE MODE)

**(d) Specifications for Outdoor Cable Construction**

1. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm
2. Each buffer tube shall contain 6 or 12 fibers as appropriate for the respective size cable.
3. The fibers shall not adhere to the inside of the buffer tube.
4. Each fiber shall be colored coded using a dual layered, UV cured acrylate coating system applied by the manufacturer. The coating shall be mechanically strippable without damaging the fiber. The fiber color code shall follow the EIA/TIA-598-A, Optical Fiber Cable Color Code.
5. The fiber coloring shall be stable during temperature cycling as stated in this specification and shall not be subjected to fading or smearing onto each other or into the buffer tube gel filling material. Colorings shall not cause fibers to stick together.
6. Each buffer tube shall be distinguishable from the other buffer tubes by using a color code. The buffer tube color code shall follow the EIA/TIA-598-A, Optical Fiber Cable Color Code.
7. Buffer tubes shall be constructed with dual-layers. The inner layer shall be made of polycarbonate and the outer layer shall be made of polyester.
8. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.
9. Buffer tubes shall be stranded around a central member of the cable using a reverse oscillation stranding process. Water blocking yarn(s) shall be applied longitudinally along the central member during stranding.
10. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink requirements of 7 CFR 1755.900.
11. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
12. The central anti-bucking member of the cable shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling.
13. Water blocking tape shall be used as stated in this specification. Gel filled water-blocking compound shall not be allowed in the cable core interstices in either the backbone cable or the lateral cables.

### -4-

### REVISION OF SECTION 614

FIBER OPTIC CABLE (SINGLE MODE)

1. For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the strand tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall be free from dirt and foreign matter.
2. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.
3. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
4. High tensile strength dielectric yarns shall be incorporated into the cable to provide tensile strength.
5. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
6. All-dielectric cables, (non-armored) shall be sheathed with medium density polyethylene, (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The MDPE shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
7. The cable jacket shall be free of holes, splits and blisters.
8. The cable jacket shall contain no metal elements and shall be of a consistent thickness.
9. Cable jackets shall be marked with sequential foot markings, year of manufacture and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within 0 to 1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be easily readable.
10. The maximum pulling tension shall be 2700 N (608 lbs) during installation (short term) and 890 N (200 lbs) long term installed.
11. The shipping, storage and operating temperature range of the cable shall be -40° C to +70°C. The installation temperature range of the cable shall be -30° C to +70°C.

### -5-

### REVISION OF SECTION 614

FIBER OPTIC CABLE (SINGLE MODE)

**(e) Quality Assurance Provisions**

1. Prior to installation, all optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
2. The cable manufacturer shall be ISO 9001 registered.
3. All optical fibers shall be tested and documentation shall be submitted for both on-reel testing and testing of fiber after installation. If any fiber strands are tested and fail to meet the minimum requirements stated in the Testing Special Provision, the entire roll of fiber cable shall be rejected.

## CONSTRUCTION REQUIREMENTS

The Contractor shall provide the Engineer with two copies of the cable manufacturer’s installation instructions for all fiber optic cable. All installation shall be in accordance with these practices except as otherwise directed by the Engineer. Additional cable costs due to damage caused by the Contractor’s neglect of recommended procedures shall be the Contractor’s responsibility.

Fiber optic cable shall be installed in continuous runs. The manufacture’s recommended limits for cable pull lengths shall not be exceeded. If fiber installation operations meet the manufacturer’s recommended limits, the remaining cable shall be laid in a figure eight pattern prior to proceeding with installation.

**(a) Fiber Optic Cable Installation**. Fiber optic cable shall be provided for the main backbone and lateral connections as shown in the plans. Cables shall be installed in continuous runs from pull box or manhole to each proceeding pull box or manhole. Under no conditions shall the fiber optic cables be cut or spliced at intermediate points without express written direction from the Engineer.

All installation shall be done in conformance with EIA/TIA standards and fiber optic cable manufacturer’s installation guidelines. The Contractor shall ensure that the cable bends maintain the proper radius during installation. The fiber optic cable shall be pulled in the conduit with a split mesh cable grip designed to provide a firm hold on the exterior covering of the cable. The Contractor shall ensure that the tensile load on the cable does not exceed the manufacturer’s recommended maximum by using a pulley system with numerical readout of the actual tension on the cable and includes a means of alerting the installer when the pulling tension approaches the manufacturer’s maximum recommended pulling tension. The Contractor may supplement this procedure with a breakaway tension limiter set below the lowest recommended tensile limit of the cables being pulled. Blowing cable is an acceptable alternative. If the Contractor chooses to use this method, submittals for cable installation shall be submitted along with complete information on fiber installation equipment.

### -6-

### REVISION OF SECTION 614

FIBER OPTIC CABLE (SINGLE MODE)

During pulling, the cable shall be continuously lubricated as it enters the conduit. The Contractor shall only use approved pulling lubricants as recommended by the cable manufacturer. Liquid detergent shall not be used.

If new fiber optic cable is installed within existing conduit, the Contractor shall be responsible for preventing damage to the existing equipment and circuitry, including fiber optic cables and wiring. The Contractor shall repair or replace any damaged circuitry at no additional cost the project and as approved by the Engineer. The Contractor shall perform operational tests to ensure the existing equipment and circuitry is in proper working condition after the installation of any new cable. This work shall be considered subsidiary to the installation of Fiber Optic Cable and no additional payment will be made. In no case, shall the number of cables and or wires within a conduit exceed the requirements of the National Electrical Code. The Contractor shall submit documentation to the Engineer supporting the conduit fill

All fiber optic cables shall include identification labels attached to the cable in each pull box, manhole or field equipment cabinet. The label shall be provided with information as shown in the ITS Pull Box project special detail.

1) Splices and Splice Closures:

The Contractor shall splice lateral cables into the backbone cable at the locations shown on the plans. The Contractor shall only cut the backbone fibers that are to be spliced to the lateral fibers. The remaining backbone fibers shall not be cut. The Contractor shall splice the cut backbone fibers to the lateral cable fibers as shown in the project plans. All splices shall be enclosed within a splice closure as approved by the Engineer. Following successful splicing, the splice closure shall be placed inside the pull box or manhole. The Contractor shall perform the work using splicing tools and hardware recommended by the cable manufacturer.

2) Lateral Fiber Optic Cable:

The Contractor shall install lateral fiber optic cable in continuous runs from the backbone cable to the field equipment cabinet. The Contractor shall leave 10 feet of slack cable in the control cabinet and 25 feet of slack cable in both the backbone cable manholes and in the intermediate pull boxes. Strain relief shall be provided for the lateral cables within the equipment cabinets at a maximum of three locations.

4) Buffer Tube Fan-Out:

The Contractor shall terminate the loose-tube lateral cable at the field equipment cabinet using a buffer tube fan-out kit. Fanned-out cables shall be terminated in a termination block with connectors to match the connectors on pre-connectorized patch cords.

**(b) Miscellaneous:** The cable manufacturer’s installation procedures and technical support concerning the items contained in this specification shall be included with all testing and splice diagrams. Also included to complete the documentation package shall be an additional copy of the installed fiber cable specifications from the manufacturer. These specifications shall match the original submittals provided to the Engineer.

### -7-

### REVISION OF SECTION 614

FIBER OPTIC CABLE (SINGLE MODE)

**Subsection 614.13 shall include the following:**

## METHOD OF MEASUREMENT

Fiber Optic Cable shall be measured by the Linear Foot for lateral cable and shall include all labor and materials required to install and terminate the cable (and make it operational) including the following items:

* All required fan-out kit tools, ancillary hardware and labor to accomplish the fan-out
* All required termination enclosures (including specified features), connectors, adapters, jumpers, pigtails, ancillary hardware and labor required to accomplish the termination.
* Identification labels shall be provided for each connector supplied in the patch panels and

 splices.

* All other work necessary to complete the item

Payment for Fiber Optic Cable will be made according to the following schedule:

* 80% upon completion of the installation
* 20 % upon the completion of successful integration and testing of each fiber strand installed and testing with the existing devices show at each termination point.

**Subsection 614.14 shall include the following:**

**BASIS OF PAYMENT**

Payment will be made under:

# Pay Item Pay Unit

Fiber Optic Cable (Single-Mode) (12 Fiber) Linear Foot

Fiber Optic Cable (Single-Mode) (96 Strand) Linear Foot