

EXPECTED IMPLEMENTATION JANUARY 2021

633 COMMUNICATION CABLE (REV 5-12-20) (FA 7-2-20) (1-21)

SUBARTICLE 633-2.1.1.1 is deleted and the following substituted:

633-2.1.1.1 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: 125 μ m, \pm 0.7 μ m
Core-to-Cladding Concentricity: \leq 0.5 μ m
Cladding Noncircularity: \leq 0.7%
Mode Field Diameter: 1,550 nm; 10.4 μ m, \pm 0.5 μ m
Coating Diameter: 245 μ m, \pm 5 μ m
Colored Fiber Nominal Diameter: 250 μ m \pm 15 μ m
Optical
Cabled Fiber Attenuation: 1,310 nm, \leq 0.4 dB/km; 1,550 nm, \leq 0.3 dB/km
Point Discontinuity: 1,310 nm, \leq 0.05 dB/km; 1,550 nm, \leq 0.05 dB/km
Cable Cutoff Wavelength (λ_{cef}): \leq 1,260 nm.
Total Dispersion: 1,625 nm \leq 23.0 ps/(nm•km)
Macrobend Attenuation: Turns – 100; Outer diameter (OD) of the mandrel – 60 mm, \pm 2 mm; \leq 0.05 dB at 1,550 nm
Cabled Polarization Mode Dispersion: \leq 0.5 ps/ $\sqrt{\text{km}}$

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.

SUBARTICLE 633-2.1.1.3 is deleted and the following substituted:

633-2.1.1.3 Color Code: Ensure that the marking and color-coding of the fibers and buffer tubes conforms to the TIA-598-D 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.

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SUBARTICLE 633-2.1.1.9.2 is deleted and the following substituted:

633-2.1.1.9.2 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 TIA -455-33B standard. Ensure that bending the fiber optic cable up to the minimum bend radius does not affect the optical characteristics of the fiber.

SUBARTICLE 633-2.1.1.9.3 is deleted and the following substituted:

633-2.1.1.9.3 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 -455-25D 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.

SUBARTICLE 633-2.1.1.9.4 is deleted and the following substituted:

633-2.1.1.9.4 Water Penetration: Ensure that the fiber optic cable is capable of withstanding the tests for water penetration defined in the TIA/EIA-455-82B 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.

SUBARTICLE 633-2.1.2.1 is deleted and the following substituted:

633-2.1.2.1 Splice Enclosures: Contain all optical fiber splices within a splice enclosure. Ensure that the enclosures provide storage for splices, 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

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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 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-771-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
Resist compression deformation to a maximum of 300 pounds.
Withstand an impact energy to a maximum of 40 foot-pounds at 0°F.
Axial Tension: 100 pounds for 30 minutes.
Cable Torsion: ten 90-degree rotations.
Cable Flexing: ten 90-degree bends.
Environmental
Hydrostatic Pressure Head: Up to 20 foot-pounds (-9 pounds per square inch).
Withstand 40 freeze/thaw temperature cycles.
Ultraviolet resistant during a maximum 30-day exposure in compliance with the requirements detailed in the ASTM B117 standard.
Chemical
Withstand a 90-day exposure to solutions of 3% sulfuric acid, 0.2 normal of sodium hydroxide, 10% Igepal®, kerosene, and be fungus resistant as required in the ASTM G21 standard.

SUBARTICLE 633-2.1.3 is deleted and the following substituted:

633-2.1.3 Cable Terminations: Use Type ST, SC, LC, or FC connectors only, as specified in the Plans or by the Engineer. Ensure that all ST-type fiber optic connectors, whether factory pre-terminated or field-installed, are 0.1 inch physical contact with preradiused tips. Ensure that ST and FC connectors include a ceramic ferrule and a metallic body, and provide a strain relief mechanism when installed on a single fiber cable that contains strength elements. Ensure that the ST-type connector provides a

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

Ensure that all connectors are compliant with the TIA/EIA-568-A and TIA/EIA-604 standards, as applicable, and are tested according to the Telcordia/Bellcore GR-326-CORE standard. When tested according to the TIA and EIA's Fiber Optic Test Procedure (FOTP)-171 (TIA/EIA-455-171A), ensure that the connectors test to an average insertion loss of less than or equal to 0.4 decibel and a maximum loss of less than or equal to 0.75 decibel. Test the connectors as detailed in FOTP-107 (TIA -455-107A) to reflectance values of less than or equal to minus 50 decibels.

SUBARTICLE 633-2.1.5.3 is deleted and the following substituted:

633-2.1.5.3 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. Submit the transmission loss test results as required by the TIA-455-61-A standard, as well as results from factory tests performed prior to shipping.
7. Ensure that the manufacturer submits 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.

SUBARTICLE 633-3.1.4 is deleted and the following substituted:

633-3.1.4 Slack Cable Storage: Provide and store fiber optic cable at each pull box and splice box to allow for future splices, additions, or repairs to the fiber network. Store the fiber optic cable without twisting or bending the cable below the minimum bend radius.

Store a total of 200 feet of fiber optic backbone cable in splice boxes, with 100 feet of cable on each side of the cable splice point or as shown in the Plans.

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Store a minimum of 100 feet of fiber optic drop cable in splice boxes or as shown in the Plans.

Store 50 feet of spare fiber optic cable in pull boxes.

SUBARTICLE 633-3.1.5.1 is deleted and the following substituted:

633-3.1.5.1 Splice Plan: Submit a splice plan showing the location and configuration of splices in the system for approval by the Engineer. Perform all splicing according to the splice plan. Document each splice location and identify the source and destination of each fiber in each splice tray. Document all fiber colors and buffer jacket colors used during installation, and develop a sequential fiber numbering plan as required in the TIA -598-D standard for color-coding in the documentation.

SUBARTICLE 633-3.1.8 is deleted and the following substituted:

633-3.1.8 Installation Testing: Notify the Engineer of cable testing at least 14 calendar days in advance. Submit the testing procedures to the Engineer for approval prior to commencement of testing. Perform all tests at 1,310 and 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. Ensure that the last calibration date of all test equipment is within the last 12 months and that the calibration certificate is maintained in the test equipment case or provided electronically when requested. Test all installed fibers (terminated and un-terminated) using methods identified in this Section. All tests must be conducted with a launch box.

Fibers containing splices, fibers terminated on both ends, terminated on one end, or backbone fibers (inside project limits and continuing outside of project limits) must be bidirectionally tested.

Drop fibers without splices (inside project limits and continuing outside of project limits), with only terminations on one end, and bare fiber on the other must be tested unidirectionally at a minimum, unless otherwise specified in the Contract Documents.

Drop fibers without splices which are unterminated on both ends (inside project limits and continuing outside of project limits) must be tested using a bare fiber adapter and tested unidirectionally at a minimum, unless otherwise specified in the Contract Documents.

SUBARTICLE 633-3.1.8.1 is deleted and the following substituted:

633-3.1.8.1 Optical Time Domain Reflectometer (OTDR)

Attenuation Testing: Perform testing on all fibers to ensure that attenuation does not exceed allowable loss (0.4 db/km for 1310 nanometer wavelength, 0.3 db/km for 1550 nanometer 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.

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ARTICLE 633-5 is deleted and the following substituted:

633-5 Method of Measurement.

The quantities to be paid will be: the length, in feet, of fiber optic cable; the number, per each, of fiber optic connections; the number, per each, of fiber optic connection hardware; and the length, per foot, of twisted pair cable, accepted by the Engineer.

The Contract unit price for communication cable, furnished and installed, will include furnishing, placement, and testing of all material, and for all tools, labor, equipment, installation hardware (such as support wire, cable ties, cable clamps, and lashing wire), supplies, support, personnel training, documentation, and incidentals necessary for a complete installation.

Payment for conductive cable terminal connectors and conductive cable grounding is considered incidental and shall be included in the price for twisted pair communication cable.

Fiber optic splices and terminations, as shown in the Plans, shall be measured per each fiber optic connection furnished and installed.

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