

G.656”), incorporation by reference approved for § 1755.902(b) and § 1755.902(q);

(4) ITU-T Recommendation G.657, *Series G: Transmission Systems and Media, Digital Systems and Networks, Transmission media characteristics—Optical fibre cables, Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network*, approved December 2006 (“ITU-T Recommendation G.657”), incorporation by reference approved for § 1755.902(b) and § 1755.902(q); and

(5) ITU-T Recommendation L.58, *Series L: Construction, Installation and Protection of Cables and Other Elements of Outside Plant, Optical fibre cables: Special Needs for Access Network*, approved March 2004 (“ITU-T Recommendation L.58”), incorporation by reference approved for § 1755.902(a).

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**§ 1755.902 Minimum performance Specification for fiber optic cables.**

(a) *Scope.* This section is intended for cable manufacturers, Agency borrowers, and consulting engineers. It covers the requirements for fiber optic cables intended for aerial installation either by attachment to a support strand or by an integrated self-supporting arrangement, for underground application by placement in a duct, or for buried installations by trenching, direct plowing, and directional or pneumatic boring.

(1) *General.* (i) Specification requirements are given in SI units which are the controlling units in this part. Approximate English equivalent of units are given for information purposes only.

(ii) The optical waveguides are glass fibers having directly-applied protective coatings, and are called “fibers,” herein. These fibers may be assembled in either loose fiber bundles with a protective core tube, encased in several protective buffer tubes, in tight buffer tubes, or ribbon bundles with a protective core tube.

(iii) Fillers, strength members, core wraps, and bedding tapes may complete the cable core.

(iv) The core or buffer tubes containing the fibers and the interstices between the buffer tubes, fillers, and strength members in the core structure

are filled with a suitable material or water swellable elements to exclude water.

(v) The cable structure is completed by an extruded overall plastic jacket. A shield or armor or combination thereof may be included under the jacket. The jacket may have strength members embedded in it, in some designs.

(vi) Buried installation requires armor under the outer jacket.

(vii) For self-supporting cable, the outer jacket may be extruded over the support messenger and cable core.

(viii) Cables for mid-span applications for network access must be designed for easy mid-span access to the fibers. The manufacturer may use reversing oscillating stranding (SZ) described in section 6.4 of ITU-T Recommendation L.58, *Construction, Installation and Protection of Cables and Other Elements of Outside Plant*, 2004 (incorporated by reference at § 1755.901(f)). The cable end user is cautioned that installed cable must be properly terminated. This includes properly securing rigid strength members (*i.e.*, central strength member) and clamping the cable and jacket. It is important that cable components be secured to prevent movement of the cable or components over the operating conditions. Central strength member (CSM) clamps must prevent movement of the CSM; positive stop CSM clamps are recommended. The CSM must be routed as straight and as short as practical to prevent bowing or breaking of the CSM. The cable and jacket retention must be sufficient to prevent jacket slippage over the operating temperature range.

(2) The normal temperature ranges for cables must meet paragraph 1.1.3 of ANSI/ICEA S-87-640, *Standard for Optical Fiber Outside Plant Communications Cable* (incorporated by reference at § 1755.901(c)).

(3) *Tensile rating.* The standard installation tensile rating for cables is 2670 N (600 lbf), unless installation involves micro type cables that utilize less stress related methods of installation, *i.e.*, blown micro-fiber cable or All-Dielectric Self-Supporting (ADSS) cables (see paragraph (c)(4) of this section).

(4) *ADSS and other self-supporting cables.* Based on the storm loading districts referenced in Section 25, Loading

of Grades B and C, of ANSI/IEEE C2-2007, *National Electrical Safety Code*, 2007 (incorporated by reference at §1755.901(b)) and the maximum span and location of cable installation provided by the end user, the manufacturer must provide a cable design with sag and tension tables showing the maximum span and sag information for that particular installation. The information included must be for Rule B, *Ice and Wind Loading*, and when applicable, information on Rule 250C, *Extreme Wind Loading*. Additionally, to ensure the proper ground clearance, typically a minimum of 4.7 m (15.5 feet), the end user should factor in the maximum sag under loaded conditions, as well as, height of attachment for each application.

(5) *Minimum bend diameter*. For cable under loaded and unloaded conditions, the cable must have the minimum bend diameters indicated in paragraph 1.1.5, *Minimum Bend Diameter*, of the ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)). For very small cables, manufacturers may specify fixed cable minimum bend diameters that are independent of the outside diameter. For cables having a non-circular cross-section, the bend diameter is to be determined using the thickness of the cable associated with the preferential bending axis.

(6) The cable is fully color coded so that each fiber is distinguishable from every other fiber. A basic color scheme of twelve colors allows individual fiber identification. Colored tubes, binders, threads, strippings, or markings provide fiber group identification.

(7) Cables must demonstrate compliance with the qualification testing requirements of this section to ensure satisfactory end-use performance characteristics for the intended applications.

(8) Optical cable designs not specifically addressed by this section may be allowed if accepted by the Agency. Justification for acceptance of a modified design must be provided to substantiate product utility and long term stability and endurance. For information on how to obtain Agency product acceptance, refer to the procedures listed at [http://www.usda.gov/rus/telecom/listing\\_procedures/](http://www.usda.gov/rus/telecom/listing_procedures/)

[index\\_listing\\_procedures.htm](#), as well as additional information in RUS Bulletin 345-3, *Acceptance of Standards, Specifications, Equipment Contract Forms, Manual Sections, Drawings, Materials and Equipment for the Telephone Program* (hereinafter "RUS Bulletin 345-3"), available for download at <http://www.usda.gov/rus/telecom/publications/bulletins.htm>.

(9) All cables sold to RUS telecommunications borrowers for projects involving RUS loan funds must be accepted by the Agency's Technical Standards Committee "A" (Telecommunications). Any design change to existing acceptable designs must be submitted to the Agency for acceptance. As stated in paragraph 8 above, refer to the procedures listed at [http://www.usda.gov/rus/telecom/listing\\_procedures/index\\_listing\\_procedures.htm](http://www.usda.gov/rus/telecom/listing_procedures/index_listing_procedures.htm) as well as RUS Bulletin 345-3.

(10) The Agency intends that the optical fibers contained in the cables meeting the requirements of this section have characteristics that will allow signals having a range of wavelengths to be carried simultaneously.

(b) *Optical fibers*. (1) The solid glass optical fibers must consist of a cylindrical core and cladding covered by either an ultraviolet-cured acrylate or other suitable coating. Each fiber must be continuous throughout its length.

(2) *Zero-dispersion*. Optical fibers must meet the fiber attributes of Table 2, *G.652.B attributes*, found in ITU-T Recommendation G.652 (incorporated by reference at §1755.901(f)). However, when the end user stipulates a low water peak fiber, the optical fibers must meet the fiber attributes of Table 4, *G.652.D attributes*, found in ITU-T Recommendation G.652; or when the end user stipulates a low bending loss fiber, the optical fibers must meet the fiber attributes of Table 7-1, *G.657 class A attributes*, found in the ITU-T Recommendation G.657 (incorporated by reference at §1755.901(f)).

(3) *Non-zero-dispersion*. Optical fibers must meet the fiber attributes of Table 1, *G.656 attributes*, found in ITU-T Recommendation G.656 (incorporated by reference at §1755.901(f)). However, when the end user specifies Recommendation A, B, C, D, or E of ITU-

T Recommendation G.655 (incorporated by reference at §1755.901(f)), the optical fibers must meet the fiber attributes of ITU-T Recommendation G.655.

(4) *Multimode fibers.* Optical fibers must meet the requirements of paragraphs 2.1 and 2.3.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(5) *Matched cable.* Unless otherwise specified by the buyer, all single mode fiber cables delivered to a RUS-financed project must be manufactured to the same MFD specification. However, notwithstanding the requirements of paragraphs (d)(2) and (d)(3) of this section, the maximum MFD tolerance allowed for cable meeting the requirements of this section must be of a magnitude meeting the definition of “matched cable,” as defined in paragraph (b) of §1755.900. With the use of cables meeting this definition the user can reasonably expect that the average bi-directional loss of a fusion splice to be  $\leq 0.1$  dB.

(6) Buyers will normally specify the MFD for the fibers in the cable. When a buyer does not specify the MFD at 1310 nm, the fibers must be manufactured to an MFD of  $9.2 \mu\text{m}$  with a maximum tolerance range of  $\pm 0.5 \mu\text{m}$  ( $362 \pm 20$  microinch), unless the end user agrees to accept cable with fibers specified to a different MFD. When the end user does specify a MFD and tolerance conflicting with the MFD maximum tolerance allowed by paragraph (d)(5) of this section, the requirements of paragraph (d)(5) must prevail.

(7) Factory splices are not allowed.

(8) *Coating.* The optical fiber must be coated with a suitable material to preserve the intrinsic strength of the glass having an outside diameter of  $250 \pm 15$  micrometers ( $10 \pm 0.6$  mils). Dimensions must be measured per the methods of paragraph 7.13 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)). The protective coverings must be free from holes, splits, blisters, and other imperfections and must be as smooth and concentric as is consistent with the best commercial practice. The diameter of the fiber, as the fiber is used in the cable, includes any coloring thickness or the uncolored coating, as the case may be. The strip force required to remove  $30 \pm 3$  millimeters (1.2

$\pm 0.1$  inch) of protective fiber coating must be between 1.0 N (0.2 pound-force) and 9.0 N (2 pound-force).

(9) All optical fibers in any single length of cable must be of the same type, unless otherwise specified by end user.

(10) Optical fiber dimensions and data reporting must be as required by paragraph 7.13.1.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(c) *Buffers.* (1) The optical fibers contained in a tube buffer (loose tube), an inner jacket (unit core), a channel, or otherwise loosely packaged must have a clearance between the fibers and the inside of the container sufficient to allow for thermal expansions of the tube buffer without constraining the fibers. The protective container must be manufactured from a material having a coefficient of friction sufficiently low to allow the fibers free movement. The loose tube must contain a suitable water blocking material. Loose tubes must be removable without damage to the fiber when following the manufacturer’s recommended procedures.

(2) The tubes for single mode loose tube cables must be designed to allow a maximum mid-span buffer tube exposure of 6.096 meters (20 feet). The buyer should be aware that certain housing hardware may require cable designed for 6.096 meters of buffer tube storage.

(3) Optical fibers covered in near contact with an extrusion (tight tube) must have an intermediate soft buffer to allow for thermal expansions and minor pressures. The buffer tube dimension must be established by the manufacturer to meet the requirement of this section. Tight buffer tubes must be removable without damage to the fiber when following the manufacturer’s recommended procedures. The tight buffered fiber must be strippable per paragraph 7.20 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(4) Both loose tube and tight tube coverings of each color and other fiber package types removed from the finished cable must meet the following shrinkback and cold bend performance requirements. The fibers may be left in the tube.

(i) *Shrinkback*. Testing must be conducted per paragraph 14.1 of ASTM D 4565 (incorporated by reference at §1755.901(d)), using a talc bed at a temperature of 95 °C (203 °F). Shrinkback must not exceed 5 percent of the original 150 millimeter (6 inches) length of the specimen. The total shrinkage of the specimen must be measured. (Buffer tube material meeting this test may not meet the mid-span test in paragraph (t)(15) of this section).

(ii) *Cold bend*. Testing must be conducted on at least one tube from each color in the cable. Stabilize the specimen to  $-30 \pm 1$  °C ( $-22 \pm 2$  °F) for a minimum of four hours. While holding the specimen and mandrel at the test temperature, wrap the tube in a tight helix ten times around a mandrel with a diameter to be greater than five times the tube diameter or 50 mm (2 inches). The tube must show no evidence of cracking when observed with normal or corrected-to-normal vision.

NOTE TO PARAGRAPH (c)(4)(ii): Channel cores and similar slotted single component core designs do not need to be tested for cold bend.

(d) *Fiber identification*. (1) Each fiber within a unit and each unit within the cable must be identifiable per paragraphs 4.2.1 and 4.3.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(2) For the following items the colors designated for identification within the cable must comply with paragraphs 4.2.2 and 4.3.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)): loose buffer tubes, tight tube buffer fibers, individual fibers in multi-fiber tubes, slots, bundles or units of fibers, and the units in cables with more than one unit.

(e) *Optical fiber ribbon*. (1) Each ribbon must be identified per paragraphs 3.4.1 and 3.4.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(2) Ribbon fiber count must be specified by the end user, *i.e.*, 2, 4, 6, 12, etc.

(3) Ribbon dimensions must be as agreed by the end user and manufacturer per paragraph 3.4.4.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(4) Ribbons must meet each of the following tests. These tests are included in the paragraphs of ANSI/ICEA

S-87-640 (incorporated by reference at §1755.901(c)), indicated in parenthesis below.

(i) Ribbon Dimensions (ANSI/ICEA S-87-640 paragraphs 7.14 through 7.14.2)—measures ribbon dimension.

(ii) Ribbon Twist Test (ANSI/ICEA S-87-640 paragraphs 7.15 through 7.15.2)—evaluates the ability of the ribbon to resist splitting or other damage while undergoing dynamic cyclically twisting the ribbon under load.

(iii) Ribbon Residual Twist Test (ANSI/ICEA S-87-640 paragraphs 7.16 through 7.16.2)—evaluates the degree of permanent twist in a cabled optical ribbon.

(iv) Ribbon Separability Test (ANSI/ICEA S-87-640 paragraphs 7.17 through 7.17.2)—evaluates the ability to separate fibers.

(5) Ribbons must meet paragraph 3.4.4.6 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), Ribbon Strippability.

(f) *Strength members*. (1) Strength members may be an integral part of the cable construction, but are not considered part of the support messenger for self-supporting optical cable.

(2) The strength members may be metallic or nonmetallic.

(3) The combined strength of all the strength members must be sufficient to support the stress of installation and to protect the cable in service.

(4) Strength members may be incorporated into the core as a central support member or filler, as fillers between the fiber packages, as an annular serving over the core, as an annular serving over the intermediate jacket, embedded in the outer jacket, or as a combination of any of these methods.

(5) The central support member or filler must contain no more than one splice per kilometer of cable. Individual fillers placed between the fiber packages and placed as annular servings over the core must contain no more than one splice per kilometer of cable. Cable sections having central member or filler splices must meet the same physical requirements as unspliced cable sections.

(6) In each length of completed cable having a metallic central member, the dielectric strength between the shield

or armor, when present, and the metallic center member must withstand at least 15 kilovolts when tested per ASTM D 4566 (incorporated by reference at §1755.901(d)). The voltage must be applied for 3 seconds minimum; no failures are allowed.

(g) *Cable core.* (1) Protected fibers may be assembled with the optional central support member, fillers and strength members in such a way as to form a cylindrical group.

(2) The standard cylindrical group or core designs commonly consist of 4, 6, 12, 18, or 24 fibers. Cylindrical groups or core designs larger than the sizes shown above must meet all the applicable requirements of this section.

(3) When threads or tapes are used in cables using water blocking elements as core binders, they must be a non-hygroscopic and non-wicking dielectric material or be rendered by the gel or water blocking material produced by the ingress of water.

(4) When threads or tapes are used as unit binders to define optical fiber units in loose tube, tight tube, slotted, or bundled cored designs, they must be non-hygroscopic and non-wicking dielectric material or be rendered by the filling compound or water blocking material contained in the binder. The colors of the binders must be per paragraphs (f)(2) and (f)(3) of this section.

(h) *Core water blocking.* (1) To prevent the ingress of water into the core and water migration, a suitable filling compound or water blocking elements must be applied into the interior of the loose fiber tubes and into the interstices of the core. When a core wrap is used, the filling compound or water blocking elements, as the case may be, must also be applied to the core wrap, over the core wrap and between the core wrap and inner jacket when required.

(2) The materials or elements must be homogeneous and uniformly mixed; free from dirt, metallic particles and other foreign matter; easily removed; nontoxic and present no dermal hazards. The filling compound and water blocking elements must contain a suitable antioxidant or be of such composition as to provide long term stability.

(3) The individual cable manufacturer must satisfy the Agency that the

filling compound or water blocking elements selected for use is suitable for its intended application by submitting test data showing compliance with ASTM D 4568 (incorporated by reference at §1755.901(d)). The filling compound and water blocking elements must be compatible with the cable components when tested per ASTM D 4568 at a temperature of 80 °C (176 °F). The jacket must retain a minimum of 85% of its un-aged tensile and elongation values.

(i) *Water blocking material.* (1) Sufficient flooding compound or water blocking elements must be applied between the inner jacket and armor and between the armor and outer jacket so that voids and air spaces in these areas are minimized. The use of flooding compound or water blocking elements between the armor and outer jacket is not required when uniform bonding, paragraph (o)(9) of this section, is achieved between the plastic-clad armor and the outer jacket.

(2) The flooding compound or water blocking elements must be compatible with the jacket when tested per paragraphs 7.19 and 7.19.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)). The aged jacket must retain a minimum of 85% of its un-aged tensile strength and elongation values when tested per paragraph 7.19.2.3. The flooding compound must exhibit adhesive properties sufficient to prevent jacket slip when tested per paragraph 7.30.1 of ANSI/ICEA S-87-640 and meets paragraph 7.30.2 of ANSI/ICEA S-87-640 for minimum sheath adherence of 14 N/mm for armored cables.

(3) The individual cable manufacturer must satisfy the Agency by submitting test data showing compliance with the appropriate cable performance testing requirements of this section that the flooding compound or water blocking elements selected for use is acceptable for the application.

(j) *Core wrap.* (1) At the option of the manufacturer, one or more layers of dielectric material may be applied over the core.

(2) The core wrap(s) can be used to provide a heat barrier to prevent deformation or adhesion between the fiber tubes or can be used to contain the core.

(k) *Inner jackets.* (1) For designs with more than one jacket, the inner jackets must be applied directly over the core or over the strength members when required by the end user. The jacket must be free from holes, splits, blisters, or other imperfections and must be as smooth and concentric as is consistent with the best commercial practice. The inner jacket must not adhere to other cable components such as fibers, buffer tubes, etc.

(2) For armored and unarmored cable, an inner jacket is optional. The inner jacket may absorb stresses in the cable core that may be introduced by armor application or by armored cable installation.

(3) The inner jacket material and test requirements must be the same as the outer jacket material, except that either black or natural polyethylene may be used and the thickness requirements are included in paragraph (m)(4) of this section. In the case of natural polyethylene, the requirements for absorption coefficient and the inclusion of furnace black are waived.

(4) The inner jacket thickness must be determined by the manufacturer, but must be no less than a nominal jacket thickness of 0.5 mm (0.02 inch) with a minimum jacket thickness of 0.35 mm (0.01 inch).

(1) *Outer jacket.* (1) The outer jacket must provide the cable with a tough, flexible, protective covering which can withstand exposure to sunlight, to atmosphere temperatures, and to stresses reasonably expected in normal installation and service.

(2) The jacket must be free from holes, splits, blisters, or other imperfections and must be as smooth and concentric as is consistent with the best commercial practice.

(3) The jacket must contain an anti-oxidant to provide long term stabilization and must contain a minimum of 2.35 percent concentration of furnace black to provide ultraviolet shielding measures as required by paragraph 5.4.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), except that the concentration of furnace black does not necessarily need to be initially contained in the raw material and may be added later during the jacket making process.

(4) The raw material used for the outer jacket must be one of the types listed below.

(i) *Type L1.* Low density, polyethylene (LDPE) must conform to the requirements of paragraph 5.4.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(ii) *Type L2.* Linear low density, polyethylene (LLDPE) must conform to the requirements of paragraph 5.4.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(iii) *Type M.* Medium density polyethylene (MDPE) must conform to the requirements of paragraph 5.4.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(iv) *Type H.* High density polyethylene (HDPE) must conform to the requirements of paragraph 5.4.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(5) Particle size of the carbon selected for use must not average greater than 20 nm.

(6) The outer jacketing material removed from or tested on the cable must be capable of meeting the performance requirements of Table 5.1 found in ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(7) *Testing Procedures.* The procedures for testing the jacket specimens for compliance with paragraph (n)(5) of this section must be as follows:

(i) *Jacket material density measurement.* Test per paragraphs 7.7.1 and 7.7.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(ii) *Tensile strength, yield strength, and ultimate elongation.* Test per paragraphs 7.8.1 and 7.8.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(iii) *Jacket material absorption coefficient test.* Test per paragraphs 7.9.1 and 7.9.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(iv) *Environmental stress crack resistance test.* For large cables (outside diameter  $\geq$  30 mm (1.2 inch)), test per paragraphs 7.10.1 through 7.10.1.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)). For small cables (Diameter  $<$  30 mm (1.2 inch)), test per paragraphs 7.10.2 through and 7.10.2.2 of ANSI/ICEA S-87-640. A crack

or split in the jacket constitutes failure.

(v) *Jacket shrinkage test.* Test per paragraphs 7.11.1 and 7.11.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(8) *Jacket thickness.* The outer jacket must meet the requirements of paragraphs 5.4.5.1 and 5.4.5.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(9) *Jacket repairs.* Repairs are allowed per paragraph 5.5 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(m) *Armor.* (1) A steel armor, plastic coated on both sides, is required for direct buried cable manufactured under this section. Armor is optional for duct and aerial cable, as required by the end user. The plastic coated steel armor must be applied longitudinally directly over the core wrap or the intermediate jacket and have a minimum overlap of 3.0 millimeters (118 mils), except for small diameter cables with diameters of less than 10 mm (394 mils) for which the minimum overlap must be 2 mm (79 mils). When a cable has a shield, the armor should normally be applied over the shielding tape.

(2) The uncoated steel tape must be electrolytic chrome coated steel (ECCS) and must meet the requirements of paragraph B.2.4 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(3) The reduction in thickness of the armoring material due to the corrugating or application process must be kept to a minimum and must not exceed 10 percent at any spot.

(4) The armor of each length of cable must be electrically continuous with no more than one joint or splice allowed in any length of one kilometer of cable. This requirement does not apply to a joint or splice made in the raw material by the raw material manufacturer.

(5) The breaking strength of any section of an armor tape, containing a factory splice joint, must not be less than 80 percent of the breaking strength of an adjacent section of the armor of equal length without a joint.

(6) For cables containing no flooding compound over the armor, the overlap portions of the armor tape must be

bonded in cables having a flat, non-corrugated armor to meet the mechanical requirements of paragraphs (t)(1) through (t)(16)(ii) of this section. If the tape is corrugated, the overlap portions of the armor must be sufficiently bonded and the corrugations must be sufficiently in register to meet the requirements of paragraphs (t)(1) through (t)(16)(ii) of this section.

(7) The armor tape must be so applied as to enable the cable to pass the Cable Low (–30 °C (–22 °F)) and High (60 °C (140 °F)) Temperatures Bend Test, as required by paragraph (t)(3) of this section.

(8) The protective coating on the steel armor must meet the Bonding-to-Metal, Heat Sealability, Lap-Shear and Moisture Resistance requirements of Type I, Class 2 coated metals per ASTM B 736 (incorporated by reference in §1755.901(d)).

(9) When the jacket is bonded to the plastic coated armor, the bond between the plastic coated armor and the outer jacket must not be less than 525 Newtons per meter (36 pound-force) over at least 90 percent of the cable circumference when tested per ASTM D 4565 (incorporated by reference at §1755.901(d)). For cables with strength members embedded in the jacket, and residing directly over the armor, the area of the armor directly under the strength member is excluded from the 90 percent calculation.

(n) *Figure 8 aerial cables.* (1) When self-supporting aerial cable containing an integrated support messenger is supplied, the support messenger must comply with the requirements specified in paragraphs D.2.1 through D.2.4 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), with exceptions and additional provisions as follows:

(i) Any section of a completed strand containing a joint must have minimum tensile strength and elongation of 29,500 Newtons (6,632 pound-force) and 3.5 percent, respectively, when tested per the procedures specified in ASTM A 640 (incorporated by reference in §1755.901(d)).

(ii) The individual wires from a completed strand which contains joints must not fracture when tested per the

“Ductility of Steel” procedures specified in ASTM A 640 (incorporated by reference at §1755.901(d)), except that the mandrel diameter must be equal to 5 times the nominal diameter of the individual wires.

(iii) The support strand must be completely covered with a flooding compound that offers corrosion protection. The flooding compound must be homogeneous and uniformly mixed.

(iv) The flooding compound must be nontoxic and present no dermal hazard.

(v) The flooding compound must be free from dirt, metallic particles, and other foreign matter that may interfere with the performance of the cable.

(2) Other methods of providing self-supporting cable specifically not addressed in this section may be allowed if accepted. Justification for acceptance of a modified design must be provided to substantiate product utility and long term stability and endurance. To obtain the Agency’s acceptance of a modified design, refer to the product acceptance procedures available at [http://www.usda.gov/rus/telecom/index\\_listing\\_procedures/](http://www.usda.gov/rus/telecom/index_listing_procedures/) as well as RUS Bulletin 345-3.

(3) *Jacket thickness requirements.* Jackets applied over an integral messenger must meet the following requirements:

(i) The minimum jacket thickness at any point over the support messenger must meet the requirements of paragraph D.3 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(ii) The web dimension for self-supporting aerial cable must meet the requirements of paragraph D.3 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(o) *Sheath slitting cord.* (1) A sheath slitting cord or ripcord is optional.

(2) When a sheath slitting cord is used it must be capable of slitting the jacket or jacket and armor, at least one meter (3.3 feet) length without breaking the cord at a temperature of  $23 \pm 5$  °C ( $73 \pm 9$  °F).

(3) The sheath slitting cord must meet the sheath slitting cord test described in paragraph (t)(1) of this section.

(p) *Identification markers.* (1) Each length of cable must be permanently identified. The method of marking

must be by means of suitable surface markings producing a clear distinguishable contrasting marking meeting paragraph 6.1.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), and must meet the durability requirements of paragraphs 7.5.2 through 7.5.2.2 of ANSI/ICEA S-87-640.

(2) The color of the initial marking must be white or silver. If the initial marking fails to meet the requirements of the preceding paragraphs, it will be permissible to either remove the defective marking and re-mark with the white or silver color or leave the defective marking on the cable and re-mark with yellow. No further re-marking is permitted. Any re-marking must be done on a different portion of the cable’s circumference where the existing marking is found and have a numbering sequence differing from any other marking by at least 3,000. Any reel of cable that contains more than one set of sequential markings must be labeled to indicate the color and sequence of marking to be used. The labeling must be applied to the reel and also to the cable.

(3) Each length of cable must be permanently labeled OPTICAL CABLE, OC, OPTICAL FIBER CABLE, or OF on the outer jacket and identified as to manufacturer and year of manufacture.

(4) Each length of cable intended for direct burial installation must be marked with a telephone handset in compliance with requirements of the Rule 350G of the ANSI/IEEE C2-2007 (incorporated by reference at §1755.901(b)).

(5) Each length of cable must be identified as to the manufacturer and year of manufacturing. The manufacturer and year of manufacturing may also be indicated by other means as indicated in paragraphs 6.1.2 through 6.1.4 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(6) The number of fibers on the jacket must be marked on the jacket.

(7) The completed cable must have sequentially numbered length markers in METERS or FEET at regular intervals of not more than 2 feet or not more than 1 meter along the outside of the jacket. Continuous sequential numbering must be employed in a single length of cable. The numbers must be



dimensioned and spaced to produce good legibility and must be approximately 3 millimeters (118 mils) in height. An occasional illegible marking is permissible when it is located within 2 meters of a legible marking for cables marked in meters or 4 feet for cables marked in feet.

(8) Agreement between the actual length of the cable and the length marking on the cable jacket must be within the limits of +1 percent and -0 percent.

(9) *Jacket print test.* Cables must meet the Jacket Print Test described in paragraphs 7.5.2.1 and 7.5.2.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(q) *Performance of a finished cable*—(1) *Zero dispersion optical fiber cable.* Unless otherwise specified by the end user, the optical performance of a finished cable must comply with the attributes of Table 2, *G.652.B attributes*, found in ITU Recommendation G.652 (incorporated by reference at §1755.901(f)). However, when the end user stipulates a low water peak fiber the finished cable must meet the attributes of Table 4, *G.652.D attributes*, found in ITU Recommendation G.652; or when the end user stipulates a low bending loss fiber, the finished cable must meet the attributes of Table 7-1, *G.657 class A attributes*, found in ITU Recommendation G.657 (incorporated by reference at §1755.901(f)).

(i) The attenuation methods must be per Table 8.4, *Optical attenuation measurement methods*, of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(ii) The cable must have a maximum attenuation of 0.1 dB at a point of discontinuity (a localized deviation of the optical fiber loss). Per paragraphs 8.4 and 8.4.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), measurements must be conducted at 1310 and 1550 nm, and at 1625 nm when specified by the end user.

(iii) The cable cutoff wavelength ( $\gamma_{cc}$ ) must be reported per paragraph 8.5.1 of ANSI/ICEA S-87-640 (incorporated by reference in §1755.901(c)).

(2) *Nonzero dispersion optical fiber cable.* Unless otherwise specified by the end user, the optical performance of the finished cable must comply with

the attributes of Table 1, *G.656 attributes*, found in ITU-T Recommendation G.656 (incorporated by reference at §1755.901(f)). When the buyer specifies Recommendation A, B, C, D or E of ITU-T Recommendation G.655 (incorporated by reference at §1755.901(f)), the finished cable must comply with the attributes of ITU-T Recommendation G.655.

(i) The attenuation methods must be per Table 8.4, *Optical attenuation measurement methods* of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(ii) The cable must have a maximum attenuation of 0.1 dB at a point of discontinuity (a localized deviation of the optical fiber loss). Per paragraphs 8.4 and 8.4.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), measurements must be conducted at 1310 and 1550 nm, and at 1625 nm when specified by the end user.

(iii) The cable cutoff wavelength ( $\gamma_{cc}$ ) must be reported per paragraph 8.5.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(3) *Multimode optical fiber cable.* Unless otherwise specified by the end user, the optical performance of the fibers in a finished cable must comply with Table 8.1, *Attenuation coefficient performance requirement (dB/k)*, Table 8.2, *Multimode bandwidth coefficient performance requirements (MHz-km)* and Table 8.3, *Points discontinuity acceptance criteria (dB)*, of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(4) Because the accuracy of attenuation measurements for single mode fibers becomes questionable when measured on short cable lengths, attenuation measurements are to be made utilizing characterization cable lengths. Master Cable reels must be tested and the attenuation values measured will be used for shorter ship lengths of cable.

(5) Because the accuracy of attenuation measurements for multimode fibers becomes questionable when measured on short cable lengths, attenuation measurements are to be made utilizing characterization cable lengths. If the ship length of cable is less than one kilometer, the attenuation values measured on longer

lengths of cable (characterization length of cable) before cutting to the ship lengths of cable may be applied to the ship lengths.

(6) Attenuation must be measured per Table 8.4, *Optical Attenuation Measurement Methods*, of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(7) The bandwidth of multimode fibers in a finished cable must be no less than the values specified in ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)), Table 8.2 per paragraphs 8.3.1 and 8.3.2.

(r) *Mechanical requirements.* Fiber optic cables manufactured under the requirements of this section must be tested by the manufacturer to determine compliance with such requirements. Unless otherwise specified, testing must be performed at the standard conditions defined in paragraph 7.3.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)). The standard optical test wavelengths to be used are 1550 nm single mode and 1300 nm multimode, unless otherwise specified in the individual test.

(1) *Sheath slitting cord test.* All cables manufactured under the requirements of this section must meet the Ripcord Functional Test described in paragraphs 7.18.1 and 7.18.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(2) *Material compatibility and cable aging test.* All cables manufactured under the requirements of this section must meet the Material Compatibility and Cable Aging Test described in paragraphs 7.19 through 7.19.2.4 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(3) *Cable low and high bend test.* Cables manufactured under the requirements of this section must meet the Cable Low (-30 °C (-22 °F)) and High (60 °C (140 °F)) Temperatures Bend Test per paragraphs 7.21 and 7.21.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(4) *Compound flow test.* All cables manufactured under the requirements of this section must meet the test described in paragraphs 7.23, 7.23.1, and 7.23.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(5) *Cyclic flexing test.* All cables manufactured under the requirements of this section must meet the Flex Test described in paragraphs 7.27 through 7.27.2 of the ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(6) *Water penetration test.* All cables manufactured under the requirements of this section must meet paragraphs 7.28 through 7.28.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(7) *Cable impact test.* All cables manufactured under the requirements of this section must meet the Cable Impact Test described in paragraphs 7.29.1 and 7.29.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(8) *Cable tensile loading and fiber strain test.* Cables manufactured under the requirements of this section must meet the Cable Loading and Fiber Strain Test described in paragraphs 7.30 through 7.30.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)). This test does not apply to aerial self-supporting cables.

(9) *Cable compression test.* All cables manufactured under requirements of this section must meet the Cable Compressive Loading Test described in paragraphs 7.31 through 7.31.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(10) *Cable twist test.* All cables manufactured under the requirements of this section must meet the Cable Twist Test described in paragraphs 7.32 through 7.32.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(11) *Cable Lighting damage susceptibility test.* Cables manufactured under the requirements of this section must meet the Cable Lighting Damage Susceptibility Test described in paragraphs 7.33 and 7.33.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(12) *Cable external freezing test.* All cables manufactured under the requirements of this section must meet the Cable External Freezing Test described in paragraphs 7.22 and 7.22.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(13) *Cable temperature cycling test.* All cables manufactured under the requirements of this section must meet the

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Cable Temperature Cycling Test described in paragraph 7.24.1 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(14) *Cable sheath adherence test.* All cables manufactured under the requirements of this section must meet the Cable Sheath Adherence Test described in paragraphs 7.26.1 and 7.26.2 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(15) *Mid-span test.* This test is applicable only to cables of a loose tube design specified for mid-span applications with tube storage. Cable of specialty design may be exempted from this requirement when this requirement is not applicable to such design. All buried and underground loose tube single mode cables manufactured per the requirements in this section and intended for mid-span applications with tube storage must meet the following mid-span test without exhibiting an increase in fiber attenuation greater than 0.1 dB and a maximum average increase over all fibers of 0.05 dB.

(i) The specimen must be installed in a commercially available pedestal or closure or in a device that mimics their performance, as follows: A length of cable sheath, equal to the mid-span length, must be removed from the middle of the test specimen so as to allow access to the buffer tubes. All binders, tapes, strength members, etc. must be removed. The buffer tubes must be left intact. The cable ends defining the ends of the mid-span length must be properly secured in the closure to the more stringent of the cable or hardware manufacturer's recommendations. Strength members must be secured with an end stop type clamp and the outer jacket must be clamped to prevent slippage. A minimum of 6.096 meters (20 feet) of cable must extend from the entry and exit ports of the closure for the purpose of making optical measurements. If a device that mimics the performance of pedestals or closures is used, the buffer tubes must be wound in a coil with a minimum width of 3 inches and minimum length of 12 inches.

(ii) The expressed buffer tubes must be loosely constrained during the test.

(iii) The enclosure, with installed cable, must be placed in an environ-

mental chamber for temperature cycling. It is acceptable for some or all of the two 20 feet (6.096 meters) cable segments to extend outside the environmental chamber.

(iv) Lids, pedestal enclosures, or closure covers must be removed if possible to allow for temperature equilibrium of the buffer tubes. If this is not possible, the manufacturer must demonstrate that the buffer tubes are at temperature equilibrium prior to beginning the soak time.

(v) Measure the attenuation of single mode fibers at 1550 ±10 nm. The supplier must certify the performance of lower specified wavelengths comply with the mid-span performance requirements.

(vi) After measuring the attenuation of the optical fibers, test the cable sample per TIA/EIA Standard 455-3A (incorporated by reference at §1755.901(e)). Temperature cycling, measurements, and data reporting must conform to TIA/EIA Standard 455-3A. The test must be conducted for at least five complete cycles. The following detailed test conditions must apply:

(A) TIA/EIA Standard 455-3A (incorporated by reference at §1755.901(e)), Section 4.1—Loose tube single mode optical cable sample must be tested.

(B) TIA/EIA Standard 455-3A (incorporated by reference at §1755.901(e)), Section 4.2—An Agency accepted 8 to 12 inch diameter optical buried distribution pedestal or a device that mimics their performance must be tested.

(C) Mid-span opening for installation of loose tube single mode optical cable in pedestal must be 6.096 meters (20 feet).

(D) TIA/EIA Standard 455-3A (incorporated by reference at §1755.901(e)), Section 5.1—3 hours soak time.

(E) TIA/EIA Standard 455-3A (incorporated by reference at §1755.901(e)), Section 5.2—Test Condition C-2, minimum -40 °C (-40 °F) and maximum 70 °Celsius (158 °F).

(F) TIA/EIA Standard 455-3A (incorporated by reference at §1755.901(e)), Section 5.7.2—A statistically representative amount of transmitting fibers in all express buffer tubes passing through the pedestal and stored must be measured.

(G) The buffer tubes in the closure or pedestal must not be handled or moved during temperature cycling or attenuation measurements.

(vii) Fiber cable attenuation measured through the express buffer tubes during the last cycle at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) and  $+70^{\circ}\text{C}$  ( $158^{\circ}\text{F}$ ) must not exceed a maximum increase of 0.1 dB and must not exceed a 0.05 dB average across all tested fibers from the initial baseline measurements. At the conclusion of the temperature cycling, the maximum attenuation increase at  $23^{\circ}\text{C}$  from the initial baseline measurement must not exceed 0.05 dB which allows for measurement noise that may be encountered during the test. The cable must also be inspected at room temperature at the conclusion of all measurements; the cable must not show visible evidence of fracture of the buffer tubes nor show any degradation of all exposed cable assemblies.

(16) *Aerial self-supporting cables.* The following tests apply to aerial cables only:

(i) *Static tensile testing of aerial self-supporting cables.* Aerial self-supporting cable must meet the test described in paragraphs D.4.1.1 through D.4.1.5 of ANSI/CEA S-87-640 (incorporated by reference at §1755.901(c)).

(ii) *Cable galloping test.* Aerial self-supporting cable made to the requirements of this section must meet the test described in paragraphs D.4.2 through D.4.2.3 of ANSI/CEA S-87-640 (incorporated by reference at §1755.901(c)).

(s) *Pre-connectorized cable.* (1) At the option of the manufacturer and upon request by the end user, the cable may be factory terminated with connectors.

(2) All connectors must be accepted by the Agency prior to their use. To obtain the Agency's acceptance of connectors, refer to product acceptance procedures available at [http://www.usda.gov/rus/telecom/listing\\_procedures/index\\_listing\\_procedures.htm](http://www.usda.gov/rus/telecom/listing_procedures/index_listing_procedures.htm) as well as RUS Bulletin 345-3.

(t) *Acceptance testing.* (1) The tests described in the Appendix to this section are intended for acceptance of cable designs and major modifications of accepted designs. What constitutes a major modification is at the discretion

of the Agency. These tests are intended to show the inherent capability of the manufacturer to produce cable products that have satisfactory performance characteristics, long life, and long-term optical stability but are not intended as field tests. After initial Rural Development product acceptance is granted, the manufacturer will need to apply for continued product acceptance in January of the third year after the year of initial acceptance. For information on Agency acceptance, refer to the product acceptance procedures available at [http://www.usda.gov/rus/telecom/listing\\_procedures/index\\_listing\\_procedures.htm](http://www.usda.gov/rus/telecom/listing_procedures/index_listing_procedures.htm), as well as RUS Bulletin 345-3.

(2) *Acceptance.* For initial acceptance, the manufacturer must submit:

(i) An original signature certification that the product fully complies with each paragraph of this section;

(ii) Qualification Test Data, per the Appendix to this section;

(iii) A set of instructions for handling the cable;

(iv) OSHA Material Safety Data Sheets for all components;

(v) Agree to periodic plant inspections;

(vi) A certification stating whether the cable, as sold to RUS Telecommunications borrowers, complies with the following two provisions:

(A) Final assembly or manufacture of the product, as the product would be used by an RUS Telecommunications borrower, is completed in the United States or eligible countries (currently, Mexico, Canada and Israel); and

(B) The cost of United States and eligible countries' components (in any combination) within the product is more than 50 percent of the total cost of all components utilized in the product. The cost of non-domestic components (components not manufactured within the United States or eligible countries) which are included in the finished product must include all duties, taxes, and delivery charges to the point of assembly or manufacture;

(vii) Written user testimonials concerning performance of the product; and

(viii) Other nonproprietary data deemed necessary.

(3) *Re-qualification acceptance.* For submission of a request for continued product acceptance after the initial acceptance, follow paragraph (v)(1) of this section and then, in January every three years, the manufacturer must submit an original signature certification stating that the product fully complies with each paragraph of this section, excluding the Qualification Section, and a certification that the products sold to RUS Telecommunications borrowers comply with paragraphs (v)(2)(vi) through (v)(2)(vi)(B) of this section. The tests of the Appendix to this section must be conducted and records kept for at least three years and the data must be made available to the Agency on request. The required data must have been gathered within 90 days of the submission. A certification must be submitted to the Agency stating that the cable manufactured to the requirements of this section has been tested per the Appendix of this section and that the cable meets the test requirements.

(4) *Initial and re-qualification acceptance requests should be addressed to:* Chairman, Technical Standards Committee “A” (Telecommunications), STOP 1550, Advanced Services Division, Rural Development Telecommunications Program, Washington, DC 20250–1500.

(5) *Tests on 100 Percent of Completed Cable.* (i) The armor for each length of cable must be tested for continuity using the procedures of ASTM D 4566 (incorporated by reference at §1755.901(d)).

(ii) Attenuation for each optical fiber in the cable must be measured.

(iii) Optical discontinuities greater than 0.1 dB must be isolated and their location and amplitude recorded.

(6) *Capability tests.* The manufacturer must establish a quality assurance system. Tests on a quality assurance basis must be made as frequently as is required for each manufacturer to determine and maintain compliance with all the mechanical requirements and the fiber and cable attributes required by this section, including:

(i) Numerical aperture and bandwidth of multimode fibers;

(ii) Cut off wavelength of single mode fibers;

(iii) Dispersion of single mode fibers;

(iv) Shrinkback and cold testing of loose tube and tight tube buffers, and mid-span testing of cables of a loose tube design with tube storage;

(v) Adhesion properties of the protective fiber coating;

(vi) Dielectric strength between the armor and the metallic central member;

(vii) Performance requirements for the fibers.

(viii) Performance requirements for the inner and outer jacketing materials;

(ix) Performance requirements for the filling and flooding compounds;

(x) Bonding properties of the coated armoring material;

(xi) Sequential marking and lettering; and

(xii) Mechanical tests described in paragraphs (t)(1) through (t)(16)(ii) of this section.

(u) *Records tests.* (1) Each manufacturer must maintain suitable summary records for a period of at least 3 years of all optical and physical tests required on completed cable by section as set forth in paragraphs (v)(5) and (v)(6) of this section. The test data for a particular reel must be in a form that it may be readily available to the Agency upon request. The optical data must be furnished to the end user on a suitable and easily readable form.

(2) Measurements and computed values must be rounded off to the number of places or figures specified for the requirement per paragraph 1.3 of ANSI/ICEA S-87-640 (incorporated by reference at §1755.901(c)).

(v) *Manufacturing irregularities.* (1) Under this section, repairs to the armor, when present, are not permitted in cable supplied to the end user.

(2) Minor defects in the inner and outer jacket (defects having a dimension of 3 millimeter or less in any direction) may be repaired by means of heat fusing per good commercial practices utilizing sheath grade compounds.

(w) *Packaging and preparation for shipment.* (1) The cable must be shipped on reels containing one continuous length of cable. The diameter of the drum must be large enough to prevent damage to the cable from reeling and unreeling. The diameter must be at

least equal to the minimum bending diameter of the cable. The reels must be substantial and so constructed as to prevent damage during shipment and handling.

(2) A circumferential thermal wrap or other means of protection must be secured between the outer edges of the reel flange to protect the cable against damage during storage and shipment. The thermal wrap must meet the requirements included in the *Thermal Reel Wrap Test*, described below. This test procedure is for qualification of initial and subsequent changes in thermal reel wraps.

(i) *Sample selection.* All testing must be performed on two 450 millimeter (18 inches) lengths of cable removed sequentially from the same fiber jacketed cable. This cable must not have been exposed to temperatures in excess of 38 °C (100 °F) since its initial cool down after sheathing.

(ii) *Test procedure.* (A) Place the two samples on an insulating material such as wood.

(B) Tape thermocouples to the jackets of each sample to measure the jacket temperature.

(C) Cover one sample with the thermal reel wrap.

(D) Expose the samples to a radiant heat source capable of heating the uncovered sample to a minimum of 71 °C (160 °F). A GE 600 watt photoflood lamp or an equivalent lamp having the light spectrum approximately that of the sun must be used.

(E) The height of the lamp above the jacket must be 380 millimeters (15 inches) or an equivalent height that produces the 71 °C (160 °F) jacket temperature on the unwrapped sample must be used.

(F) After the samples have stabilized at the temperature, the jacket temperatures of the samples must be recorded after one hour of exposure to the heat source.

(G) Compute the temperature difference between jackets.

(H) The temperature difference between the jacket with the thermal reel wrap and the jacket without the reel wrap must be greater than or equal to 17 °C (63 °F).

(3) Cables must be sealed at the ends to prevent entrance of moisture.

(4) The end-of-pull (outer end) of the cable must be securely fastened to prevent the cable from coming loose during transit. The start-of-pull (inner end) of the cable must project through a slot in the flange of the reel, around an inner riser, or into a recess on the flange near the drum and fastened in such a way to prevent the cable from becoming loose during installation.

(5) Spikes, staples or other fastening devices must be used in a manner which will not result in penetration of the cable.

(6) The arbor hole must admit a spindle 63.5 millimeters (2.5 inches) in diameter without binding.

(7) Each reel must be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

(8) Each reel must be stenciled or lettered with the name of the manufacturer.

(9) The following information must be either stenciled on the reel or on a tag firmly attached to the reel: Optical Cable, Type and Number of Fibers, Armored or Non-armored, Year of Manufacture, Name of Cable Manufacturer, Length of Cable, Reel Number, 7 CFR 1755.902, Minimum Bending Diameter for both Residual and Loaded Condition during installation.

*Example:* Optical Cable, G.657 class A, 4 fibers, Armored, XYZ Company, 1050 meters, Reel Number 3, 7 CFR 1755.902. Minimum Bending Diameter: Residual (Installed): 20 times Cable O.D., Loaded Condition: 40 times Cable O.D.

APPENDIX TO § 1755.902

FIBER OPTIC CABLES

BULLETIN 1753F-601(PE-90) QUALIFICATIONS TEST DATA

[Initial qualification and three year re-qualification test data required for TELECOMMUNICATIONS PROGRAM product acceptance. Please note that some tests may apply only to a particular cable design.]

Paragraph	Test	Initial qualification	3 Year re-qualification
(e)(4)(i) .....	Shrinkback .....	X	

FIBER OPTIC CABLES—Continued  
 BULLETIN 1753F–601(PE–90) QUALIFICATIONS TEST DATA

[Initial qualification and three year re-qualification test data required for TELECOMMUNICATIONS PROGRAM product acceptance. Please note that some tests may apply only to a particular cable design.]

Paragraph	Test	Initial qualification	3 Year re-qualification
(e)(4)(ii)	Cold Bend	X	
(f)(1)	Sheath Slitting Cord	X	
(f)(2)	Material Compatibility	X	
(f)(3)	Cable Low & High Bend	X	X
(f)(4)	Compound Flow	X	
(f)(5)	Cyclic Flexing	X	X
(f)(6)	Water Penetration	X	X
(f)(7)	Cable Impact	X	X
(f)(8)	Cable Tensile Loading & Fiber Strain	X	X
(f)(9)	Cable Compression	X	
(f)(10)	Cable Twist	X	X
(f)(11)	Cable Lighting Damage Susceptibility	X	
(f)(12)	Cable External Freezing	X	
(f)(13)	Cable Temperature Cycling	X	X
(f)(14)	Cable Sheath Adherence	X	
(f)(15)	Mid-Span	X	X
(f)(16)(i)	Static Tensile Testing of Aerial Self-Supporting Cables	X	X
(f)(16)(ii)	Cable Galloping	X	
(g)(2)(i)	Thermal Reel Wrap test	X	

[74 FR 20561, May 5, 2009]

**§ 1755.903 Fiber optic service entrance cables.**

(a) *Scope.* This section covers Agency requirements for fiber optic service entrance cables intended for aerial installation either by attachment to a support strand or by an integrated self-supporting arrangement, for underground application by placement in a duct, or for buried installations by trenching, direct plowing, directional or pneumatic boring. Cable meeting this section is recommended for fiber optic service entrances having 12 or fewer fibers with distances less than 100 meters (300 feet).

(1) *General.* (i) Specification requirements are given in SI units which are the controlling units in this part. Approximate English equivalent of units are given for information purposes only.

(ii) The optical waveguides are glass fibers having directly-applied protective coatings, and are called “fibers,” herein. These fibers may be assembled in either loose fiber bundles with a protective core tube, encased in several protective buffer tubes, in tight buffer tubes, or ribbon bundles with a protective core tube.

(iii) Fillers, strength members, core wraps, and bedding tapes may complete the cable core.

(iv) The core or buffer tubes containing the fibers and the interstices between the buffer tubes, fillers, and strength members in the core structure are filled with a suitable material or water swellable elements to exclude water.

(v) The cable structure is completed by an extruded overall plastic jacket. A shield or armor or combination thereof may be included under the jacket. This jacket may have strength members embedded in it, in some designs.

(vi) For rodent resistance or for additional protection with direct buried installations, it is recommended the use of armor under the outer jacket.

(vii) For self-supporting cable the outer jacket may be extruded over the support messenger and cable core.

(viii) For detection purposes, the cable may have toning elements embedded or extruded with the outer jacket.

(2) The cable is fully color coded so that each fiber is distinguishable from every other fiber. A basic color scheme of twelve colors allows individual fiber identification. Colored tubes, binders, threads, striping, or markings provide fiber group identification.