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(F) RUS designation letter “K.”

(3) When CCSR and NMR aerial service wires are shipped in coils the following provisions shall apply:

(i) The diameter of the coil shall be large enough to prevent damage to the wire from coiling or uncoiling;

(ii) The nominal length of the wire in a coil shall be 305 meters (1,000 feet). No coil shall be less than 290 meters (950 feet) long or more than 460 meters (1,500 feet) long; however, 25 percent of the total number of coils may be less than 305 meters (1,000 feet);

(iii) The coils of wire shall be wound securely with strong tape in four separate evenly spaced places;

(iv) The coils may be protected from damage by wrapping the coil with heavy paper, burlap, or other suitable material accepted by RUS prior to its use. The use of the heavy paper, burlap, or other suitable means of protection shall be at the option of the manufacturer unless specified by the end user; and

(v) Each coil shall be tagged with the following information:

(A) Customer order number;

(B) Manufacturer’s name and product code;

(C) Year of manufacture;

(D) Gauge of conductors and pair size of wire;

(E) Length of wire; and

(F) RUS designation letter “K.”

(4) In lieu of wrapping the coil with heavy paper, burlap, or other suitable material, the coil may be packaged in a moisture resistant carton.

(5) When the coils are shipped in moisture resistant cartons, each carton shall be marked with the information specified in paragraphs (f)(3)(v)(A) through (f)(3)(v)(F) of this section.

(6) Other methods of shipment may be used if accepted by RUS prior to their use.

(7) When NMR aerial service wire is shipped, the ends of the wire shall be sealed in accordance with ANSI/CEA S-89-648-1993, paragraph 9.2.

[61 FR 26077, May 24, 1996, as amended at 69 FR 18803, Apr. 9, 2004]

**§§ 1755.705–1755.859 [Reserved]**

**§ 1755.860 RUS specification for filled buried wires.**

(a) *Scope.* (1) This section covers the requirements for filled buried wires intended for direct burial as a subscriber drop and/or distribution wire.

(i) The conductors are solid copper, individually insulated with an extruded solid insulating compound.

(ii) The insulated conductors are twisted into pairs (a star-quad configuration is permitted for the two pair wires) which are then stranded or oscillated to form a cylindrical core.

(iii) A moisture resistant filling compound is applied to the stranded conductors completely covering the insulated conductors and filling the interstices between the pairs.

(iv) The wire structure is completed by the application of an optional core wrapping material, an inner jacket, a flooding compound, a shield, a flooding compound, and an overall plastic jacket.

(2) The number of pairs and gauge size of conductors which are used within the RUS program are provided in the following table:

American Wire Gauge (AWG)	22 .....	24
Pairs	2 .....	2
	3 .....	3

(3) All wires sold to RUS borrowers for projects involving RUS loan funds under this section must be accepted by RUS Technical Standards Committee “A” (Telephone). For wires manufactured to the specification of this section, all design changes to an accepted design must be submitted for acceptance. RUS will be the sole authority on what constitutes a design change.

(4) Materials, manufacturing techniques, or wire designs not specifically addressed by this section may be allowed if accepted by RUS. Justification for acceptance of modified materials, manufacturing techniques, or wire designs must be provided to substantiate product utility and long term stability and endurance.

(5) The American National Standards Institute/Electronic Industries Association (ANSI/EIA) 359-A-84, EIA Standard

Colors for Color Identification and Coding, referenced in this section is incorporated by reference by RUS. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of ANSI/EIA 359-A-84 are available for inspection during normal business hours at RUS, room 2845, U.S. Department of Agriculture, Washington, DC 20250-1500, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html). Copies are available from EIA, 2001 Pennsylvania Avenue, NW., suite 900, Washington, DC 20006, telephone number (202) 457-4966.

(6) American Society for Testing and Materials specifications (ASTM) A 505-87, Standard Specification for Steel, Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled, General Requirements for; ASTM B 3-90, Standard Specification for Soft or Annealed Copper Wire; ASTM B 193-87, Standard Test Method for Resistivity of Electrical Conductor Materials; ASTM B 224-91, Standard Classification of Coppers; ASTM B 694-86, Standard Specification for Copper, Copper Alloy, and Copper-Clad Stainless Steel Sheet and Strip for Electrical Cable Shielding; ASTM D 150-87, Standard Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials; ASTM D 257-91, Standard Test Methods for D-C Resistance or Conductance of Insulating Materials; ASTM D 1238-90b, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer; ASTM D 1248-84(1989), Standard Specification for Polyethylene Plastics Molding and Extrusion Materials; ASTM D 1535-89, Standard Test Method for Specifying Color by the Munsell System; ASTM D 3349-86, Standard Test Method for Absorption Coefficient of Carbon Black Pigmented Ethylene Plastic; ASTM D 4101-82(1988), Standard Specification for Propylene Plastic Injection and Extrusion Materials; ASTM D 4565-90a, Standard Test Methods for Physical and Environmental Performance Properties of Insulations

and Jackets for Telecommunications Wire and Cable; ASTM D 4566-90, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable; ASTM D 4568-86, Standard Test Methods for Evaluating Compatibility between Cable Filling and Flooding Compounds and Polyolefin Cable Materials; ASTM D 4872-88, Standard Test Method for Dielectric Testing of Wire and Cable Filling Compounds; ASTM E 8-91, Standard Test Methods of Tension Testing of Metallic Materials; and ASTM E 29-90, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications, referenced in this section are incorporated by reference by RUS. These incorporations by references were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of the ASTM standards are available for inspection during normal business hours at RUS, room 2845, U.S. Department of Agriculture, Washington, DC 20250-1500, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html). Copies are available from ASTM, 1916 Race Street, Philadelphia, Pennsylvania 19103-1187, telephone number (215) 299-5585.

(b) *Conductors and conductor insulation.* (1) Each conductor must be a solid round wire of commercially pure annealed copper. Conductors must meet the requirements of the American Society for Testing and Materials (ASTM) B 3-90 except that requirements for *Dimensions and Permissible Variations* are waived and elongation requirements are superseded by this section.

(2) The minimum conductor elongation in the final wire must comply with the following limits when tested in accordance with ASTM E 8-91.

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Conductor—AWG	Minimum Elongation—Percent
22	20
24	16

(3) Joints made in conductors during the manufacturing process may be brazed, using a silver alloy solder and nonacid flux, or they may be welded using either an electrical or cold welding technique. In joints made in uninsulated conductors, the two conductor ends must be butted. Splices made in insulated conductors need not be butted but may be joined in a manner acceptable to RUS.

(4)(i) The tensile strength of any section of a conductor containing a factory joint must not be less than 85 percent of the tensile strength of an adjacent section of the solid conductor of equal length without a joint.

(ii) *Engineering Information:* The sizes of wire used and their nominal diameters shall be as shown in the following table:

AWG	Nominal Diameter	
	Millimeters (mm)	(Inches (in.))
22	0.643	(0.0253)
24	0.511	(0.0201)

(5) Each conductor must be insulated with either a colored, solid, insulating grade, high density polyethylene or crystalline propylene/ethylene copolymer or with a solid natural primary layer and a colored, solid outer skin using one of the insulating materials listed in paragraphs (b)(5)(i) through (b)(5)(ii) of this section.

(i) The polyethylene raw material selected to meet the requirements of this section must be Type III, Class A, Category 4 or 5, Grade E9, in accordance with ASTM D 1248–84(1989).

(ii) The crystalline propylene/ethylene raw material selected to meet the requirements of this section must be Class PP 200B 40003 E11 in accordance with ASTM D 4101–82(1988).

(iii) Raw materials intended as conductor insulation furnished to these requirements must be free from dirt, metallic particles, and other foreign matter.

(iv) All insulating raw materials must be accepted by RUS prior to their use.

(6) All conductors in any single length of wire must be insulated with the same type of material.

(7) A permissible overall performance level of faults in conductor insulation must average not greater than one fault per 12,000 conductor meters (40,000 conductor feet) for each gauge of conductor.

(i) All insulated conductors must be continuously tested for insulation faults during the twinning operation with the method of test acceptable to RUS. The length count and number of faults must be recorded. The information must be retained for a period of 6 months and be available for review by RUS when requested.

(ii) The voltages for determining compliance with the requirements of this section are as follows:

AWG	Direct Current Voltages (Kilovolts)
22	6.0
24	5.0

(8) Repairs to the conductor insulation during manufacturing are permissible. The method of repair must be accepted by RUS prior to its use. The repaired insulation must be capable of meeting the relevant electrical requirements of this section.

(9) All repaired sections of insulation must be retested in the same manner as originally tested for compliance with paragraph (b)(7) of this section.

(10) Colored insulating material removed from or tested on the conductor, from a finished wire, must be capable of meeting the following performance requirements:

Property	Polyethylene	Crystalline Propylene/Ethylene Copolymer
Melt Flow Rate		
Percent increase from raw material, Maximum.		
<0.5 (Initial Melt Index).	50	—
0.5–2.00 (Initial Melt Index).	25	—

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Property	Poly-ethylene	Crystalline Propylene/Ethylene Copolymer
≤5.0 (Initial Melt Index).	—	110
Tensile Strength—Minimum Megapascals (MPa).	16.5	21.0
(Pounds per Square Inch (psi)).	(2,400)	(3,000)
Ultimate Elongation Minimum, Percent.	300	300
Cold Bend Failures, Maximum.	0/10	0/10
Shrinkback Maximum, mm (in.).	10 (0.375)	10 (0.375)
Oxygen Induction Time Minimum, Minutes.	20	20

(11) *Testing procedures.* The procedures for testing the insulation samples for compliance with paragraph (b)(10) of this section must be as follows.

(i) *Melt flow rate.* The melt flow rate must be determined as described in ASTM D 1238-90b. Condition E must be used for polyethylene. Condition L must be used for crystalline propylene/ethylene copolymer. The melt flow test must be conducted prior to the filling operation.

(ii) *Tensile strength and ultimate elongation.* Samples of the insulation material, removed from the conductor, must be tested in accordance with ASTM D 4565-90a using the following conditions. The minimum length of unclamped specimen must be 50 mm (2.0 in.). The minimum speed of jaw separation must be 25 mm (1.0 in.) per minute per 25 mm (1.0 in.) of unclamped specimen. The temperature of specimens and surrounding shall be  $23 \pm 1$  °C.

NOTE: Quality assurance testing at a jaw separation speed of 500 mm/min (20 in./min) is permissible. Failures at this rate must be retested at the 50 mm/min (2 in./min) rate to determine section compliance.

(iii) *Cold bend.* Samples of the insulation material on the conductor must be tested in accordance with ASTM D

4565-90a at a temperature of  $-40 \pm 1$  °C with a mandrel diameter equal to 3 times the outside diameter of the insulated conductor. There must be no cracks visible to normal or corrected-to-normal vision.

(iv) *Shrinkback.* Samples of insulation must be tested for four hours in accordance with ASTM D 4565-90a. The temperature for the type of material is listed as follows:

Material	Temperature
Polyethylene	$115 \pm 1$ °C
Crystalline propylene/ethylene Copolymer	$130 \pm 1$ °C

(v) *Oxygen induction time.* Samples of insulation, which have been conditioned in accordance with paragraph 17.3 of ASTM D 4565-90a, must be tested in accordance with the procedures of ASTM D 4565-90a using copper pans and a test temperature of  $199 \pm 1$  °C.

(12) Other methods of testing may be used if acceptable to RUS.

(c) *Identification of pairs and twisting of pairs.* (1) The insulation must be colored to identify:

(i) The tip and ring conductor of each pair; and

(ii) Each pair in the completed wire.

(2) The colors to be used to provide identification of the tip and ring conductor of each pair are shown in the following table:

Pair No.	Color	
	Tip	Ring
1	White	Blue
2	White	Orange
3	White	Green

(3) *Standards of color.* The colors of the insulated conductors supplied in accordance with this section are specified in terms of the Munsell Color System (ASTM D 1535-89) and must comply with the "Table of Wire and Cable Limit Chips" as defined in ANSI/EIA-359-A-84. (Visual color standards meeting these requirements may be obtained directly from the Munsell Color Company, Inc., 2441 North Calvert Street, Baltimore, Maryland 21218).

(4) Positive identification of the tip and ring conductors of each pair by marking each conductor of a pair with

the color of its mate is permissible. The method of marking must be accepted by RUS prior to its use.

(5) Other methods of providing positive identification of the tip and ring conductors of each pair may be employed if accepted by RUS prior to its use.

(6) The insulated conductors must be twisted into pairs.

(7) In order to provide sufficiently high crosstalk isolation, the pair twists must be designed to enable the wire to meet the capacitance unbalance and the crosstalk loss requirements of paragraphs (m)(2), (m)(3), and (m)(4) of this section.

(8) The average length of pair twists in any pair in the finished wire, when measured on any 3 meter (m) (10 foot(ft)) length, must not exceed 152 mm (6 in.).

(9) An alternative method of forming the two pair wire is the use of a star-quad configuration.

(i) The assembly of the star-quad must be such as to enable the wire to meet the capacitance unbalance and the crosstalk loss requirements of paragraphs (m)(2), (m)(3), and (m)(4) of this section.

(ii) The four individual insulated conductors must be twisted together to form a star-quad configuration with the tip and ring conductors of each pair diagonally opposite each other in the quad.

(iii) The average length of twist for the star-quad in the finished wire, when measured on any 3 m (10 ft) length, must not exceed 152 mm (6 in.).

(iv) The following color scheme must be used to provide identification of the tip and ring conductor of each pair in the star-quad:

Pair No.	Color	
	Tip	Ring
1	White with blue stripe.	Blue
2	White with orange stripe.	Orange

(v) If desired, the blue and orange conductors may contain a white stripe. The stripes in this case must be narrow enough so that the tip and ring identification is obvious.

(d) *Forming of the wire core.* (1) Twisted pairs or star-quad configuration must be assembled in such a way as to form a substantially cylindrical group.

(2) The filling compound must be applied to the wire core in such a way as to provide a completely filled core as is commercially practical.

(3) If desired for manufacturing reasons, white or colored binders of non-hygroscopic and nonwicking material may be applied over the core.

(e) *Filling compound.* (1) After or during the stranding operation and prior to application of the optional core wrap and inner jacket, a homogeneous filling compound free of agglomerates must be applied to the wire core. The compound must be as nearly colorless as is commercially feasible and consistent with the end product requirements and pair identification.

(2) The filling compound must be free from dirt, metallic particles, and other foreign matter. It must be applied in such a way as to fill the space within the wire core.

(3) The filling compound must be nontoxic and present no dermal hazards.

(4) The filling compound must exhibit the following dielectric properties at a temperature of  $23 \pm 3$  °C when measured in accordance with ASTM D 150-87 or ASTM D 4872-88.

(i) The dissipation factor must not exceed 0.0015 at a frequency of 1 megahertz (MHz).

(ii) The dielectric constant must not exceed 2.30.

(5) The volume resistivity must not be less than  $10^{12}$  ohm-cm at a temperature of  $23 \pm 3$  °C when measured in accordance with ASTM D 257-91 or ASTM D 4872-88.

(6) The individual wire manufacturer must satisfy RUS that the filling compound selected for use is suitable for its intended application. The filling compound must be compatible with the wire components when tested in accordance with ASTM D 4568-86 at a temperature of 80 °C.

(f) *Core wrap (optional).* (1) When a core wrap is used, it must consist of a layer of nonhygroscopic and nonwicking dielectric material. The wrap must be applied with an overlap.

(2) The core wrap must provide a sufficient heat barrier to prevent visible evidence of conductor insulation deformation or adhesion between conductors, caused by adverse heat transfer during the inner jacketing operation.

(3) If required for manufacturing reasons, white or colored binders of non-hygroscopic and nonwicking material may be applied over the core wrap.

(4) Sufficient filling compound must be applied to the core wrap that voids or air spaces existing between the core and inner side of the core wrap are minimized.

(g) *Inner jacket.* (1) An inner jacket must be applied over the core and/or core wrap.

(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 inner jacket material and test requirements must be as specified for the outer jacket material per paragraphs (j)(3) through (j)(5)(iv) of this section.

(4) The inner jacket thickness at any point must not be less than 0.5 mm (0.020 in.). The thickness must be determined from measurements on 50 mm (2 in.) samples taken not less than 0.3 m (1 ft) from either end of the wire. The average must be determined from 4 readings taken approximately 90° apart on any cross section of the samples. The maximum and minimum points must be determined by exploratory measurements. The maximum thickness minus the minimum thickness at any cross section must not exceed 43 percent of the average thickness at that cross section.

(h) *Flooding compound.* (1) Sufficient flooding compound must be applied on all sheath interfaces so that voids and air spaces in these areas are minimized.

(2) The flooding compound must be compatible with the jacket when tested in accordance with ASTM D 4568-86 at a temperature of 80 °C. The floodant must exhibit adhesive properties sufficient to prevent jacket slip when tested in accordance with the requirements of appendix A, paragraph (III)(5), of this section.

(3) The individual wire manufacturer must satisfy RUS that the flooding compound selected for use is acceptable for the application.

(i) *Shield.* (1) A shield must be applied either longitudinally or helically over the inner jacket.

(i) If the shield is applied longitudinally, it must be corrugated.

(ii) If the shield is applied helically, it must be smooth.

(2) The overlap for longitudinally applied shields must be a minimum of 2 mm (0.075 in.) The overlap for helically applied shields must be a minimum of 23 percent of the tape width.

(3) General requirements for application of the shielding material are as follows:

(i) Successive lengths of shielding tapes may be joined during the manufacturing process by means of cold weld, electric weld, soldering with a nonacid flux, or other acceptable means;

(ii) Where two ends of a metal shield are to be joined together, care shall be taken to clean the metal surfaces in order to provide for a good mechanical and electrical connection;

(iii) The shields of each length of wire must be tested for continuity. A one meter (3 ft) section of shield containing a factory joint must exhibit not more than 110 percent of the resistance of a shield of equal length without a joint;

(iv) The breaking strength of any section of a shield tape containing a factory joint must not be less than 80 percent of the breaking strength of an adjacent section of the shield of equal length without a joint;

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

(vi) The shielding material must be applied in such a manner as to enable the wire to pass the bend test as specified in paragraph (n)(3) of this section.

(4) The following materials are acceptable for use as wire shielding:

Standard Wire	Gopher Resistant Wire
Copper Alloy 220 (Bronze). (0.1016 ±0.0076 mm) ...	Copper-Clad Stainless Steel 0.1270 ±0.0127 mm

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Standard Wire	Gopher Resistant Wire
(0.0040 ±0.0003 in.) ..... Copper Alloy 220 (Bronze).	(0.0050 ±0.0005 in.) Copper Alloy 664
0.1270 ±0.0127 mm ..... (0.0050 ±0.0005 in.) .....	0.1397 ±0.0127 mm (0.0055 ±0.0005 in.) Copper-Clad Alloy Steel 0.1270 ±0.0127 (0.0050 ±0.0005 in.)

(i) The copper-clad steels and copper alloy 664 shielding tapes must be capable of meeting the following performance requirements prior to application to the wire:

Property	Requirement
Tensile Strength Minimum, MPa (psi) .....	379 (55,000)
Tensile Yield Minimum, MPa (psi) .....	241 (35,000)
Elongation Minimum, percent in 50 mm (2 in.).	15

(ii) *Copper alloy 220.* The shielding material, prior to application to the wire, must be in the fully annealed condition and shall conform to the requirements of ASTM B 694-86 for C22000 commercial bronze.

(iii) *Copper-clad stainless steel.* In addition to meeting the requirements of paragraph (i)(4)(i) of this section, the shielding material, prior to application to the wire, must be in the fully annealed condition and must conform to the requirements of ASTM B 694-86, with a cladding ratio of 16/68/16 and must have a minimum electrical conductivity of 28 percent IACS when measured in accordance with ASTM B 193-87.

(iv) *Copper alloy 664.* In addition to meeting the requirements of paragraph (i)(4)(i) of this section, the shielding material, prior to application to the wire, must be annealed temper and must conform to the requirements of ASTM B 694-86 and must have a minimum electrical conductivity of 28 percent IACS when measured in accordance with ASTM B 193-87.

(v) *Copper-clad alloy steel.* In addition to meeting the requirements of paragraph (i)(4)(i) of this section, the shielding material, prior to application to the wire, must be in the fully annealed condition and the copper com-

ponent must conform to the requirements of ASTM B 224-91 and the alloy steel component must conform to the requirements of ASTM A 505-87, with a cladding ratio of 16/68/16, and must have a minimum electrical conductivity of 28 percent IACS when measured in accordance with ASTM B 193-87.

(j) *Outer jacket.* (1) The outer jacket must provide the wire with a tough, flexible, protective covering which can withstand exposure to sunlight, to atmospheric temperatures and 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 raw material used for the outer jacket must be one of the five types listed in paragraphs (j)(3)(i) through (j)(3)(v) of this section. The raw material must contain an anti-oxidant to provide long term stabilization and the materials must contain a 2.60 ±0.25 percent concentration of furnace black to provide ultraviolet shielding. Both the antioxidant and furnace black must be compounded into the material by the raw material supplier.

(i) Low density, high molecular weight polyethylene (LDHMW) must conform to the requirements of ASTM D 1248-84(1989), Type I, Class C, Category 4 or 5, Grade J3.

(ii) Low density, high molecular weight ethylene copolymer (LDHMW) must conform to the requirements of ASTM D 1248-84 (1989), Type I, Class C, Category 4 or 5, Grade J3.

(iii) Linear low density, high molecular weight polyethylene (LLDHMW) must conform to the requirements of ASTM D 1248-84(1989), Type I, Class C, Category 4 or 5, Grade J3.

(iv) High density polyethylene (HD) must conform to the requirements of ASTM D 1248-84(1989), Type III, Class C, Category 4 or 5, Grade J4.

(v) Medium density polyethylene (MD) must conform to the requirements of ASTM D 1248-84(1989), Type II, Class C, Category 4 or 5, Grade J4.

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

(vii) Absorption coefficient must be a minimum of 400 in accordance with the procedures of ASTM D 3349-86.

(4) The outer jacketing material removed from or tested on the wire must be capable of meeting the following performance requirements:

Property	LLDHHMW, Ethylene Co-polymer	LDHHMW Poly-ethylene	HD or MD Polyethylene
Melt Flow Rate Percent increase from raw material Maximum .....		50	50
<0.41 (Initial Melt Index) .....	100	—	—
0.41–2.00 (Initial Melt Index) .....	50	—	—
Tensile Strength Minimum, MPa (psi) .....	12.0 (1,700)	12.0 (1,700)	16.5 (2,400)
Ultimate Elongation Percent, Minimum .....	400	400	300
Shrinkback Percent of Length, Maximum .....	5	5	5
Impact Failures, Maximum .....	2/10	2/10	2/10

(5) *Testing procedures.* The procedures for testing the jacket samples for compliance with paragraph (j)(4) of this section must be as follows:

(i) *Melt flow rate.* The melt flow rate must be as determined by ASTM D 1238-90b, Condition E. Jacketing material must be free from flooding and filling compound.

(ii) *Tensile strength and ultimate elongation.* Test in accordance with ASTM D 4565-90a, using a jaw separation speed of 500 mm/min (20 in./min) for low density material and 50 mm/min (2 in./min) for high and medium density materials.

(iii) *Shrinkback.* Test in accordance with the procedures specified in ASTM D 4565-90a using a test temperature of 100 ±1 °C for low density material and a test temperature of 115 ±1 °C for high and medium density materials.

(iv) *Impact.* The test must be performed in accordance with ASTM D 4565-90a using an impact force of 4 newton-meter (3 pound force-foot) at a temperature of –20 ±2 °C. The cylinder must strike the sample at the shield overlap. A crack or split in the jacket constitutes failure.

(6) *Jacket thickness.* The minimum jacket thickness must be 0.64 mm (0.025 in.) except that the minimum thickness over the sheath slitting cord, if present, must be 0.46 mm (0.018 in.). The minimum point must be determined by exploratory measurements. The average thickness at any cross section must be determined from four readings including the minimum point,

taken approximately 90 °apart. The thickness measurement must exclude any jacket material that has formed into the corrugation. The maximum thickness at any cross section must not be greater than 155 percent of the minimum thickness.

(7) *Eccentricity.* The eccentricity of the jacket must not exceed 43 percent when calculated using the formula as follows:

$$\frac{\text{Maximum Thickness} - \text{Minimum Thickness}}{\text{Average Thickness}} \times 100 \text{ Percent}$$

(k) *Sheath slitting cord (optional).* (1) Sheath slitting cords may be used in the wire structure at the option of the manufacturer.

(2) When a sheath slitting cord is used it must be nonhygroscopic and nonwicking, continuous throughout a length of wire, and of sufficient strength to open the sheath without breaking the cord.

(3) Sheath slitting cords must be capable of consistently slitting the jacket(s) and/or shield for a continuous length of 0.6 m (2 ft) when tested in accordance with the procedure specified in appendix B of this section.

(1) *Identification marker and length marker.* (1) Each length of wire must be permanently identified as to manufacturer and year of manufacture.

(2) The number of conductor pairs and their gauge size must be marked on the jacket.



(3) The marking must be printed on the jacket at regular intervals of not more than 1.5 m (5 ft).

(4) An alternative method of marking may be used if accepted by RUS prior to its use.

(5) The completed wire must have sequentially numbered length markers in FEET OR METERS at regular intervals of not more than 1.5 m (5 ft) along the outside of the jacket.

(6) The method of length marking must be such that for any single length of wire, continuous sequential numbering must be employed.

(7) The numbers must be dimensioned and spaced to produce good legibility and must be approximately 3 mm (0.125 in.) in height. An occasional illegible marking is permissible if there is a legible marking located not more than 1.5 m (5 ft) from it.

(8) The method of marking must be by means of suitable surface markings producing a clear, distinguishable, contrasting marking acceptable to RUS. Where direct or transverse printing is employed, the characters should be indented to produce greater durability of marking. Any other method of length marking must be acceptable to RUS as producing a marker suitable for the field. Size, shape and spacing of numbers, durability, and overall legibility of the marker will be considered in acceptance of the method.

(9) The accuracy of the length marking must be such that the actual length of any wire section is never less than the length indicated by the marking and never more than one percent greater than the length indicated by the marking.

(10) 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 wire and re-mark with yellow. No further re-marking is permitted. Any re-marking must be on a different portion of the wire circumference than any existing marking when possible and have a numbering sequence differing from any other existing marking by at least 5,000.

(11) Any reel of wire which 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 wire.

(m) *Electrical requirements*—(1) *Mutual capacitance and conductance*. (i) The average mutual capacitance (corrected for length) of all pairs in any reel must not exceed 52  $\pm 4$  nanofarad/kilometer (nF/km) (83  $\pm 7$  nanofarad/mile (nF/mile)) when tested in accordance with ASTM D 4566-90 at a frequency of 1.0  $\pm 0.1$  kilohertz (kHz) and a temperature of 23  $\pm 3$  °C.

(ii) The mutual conductance (corrected for length and gauge) of any pair must not exceed 2 micromhos/kilometer (micromhos/km) (3.3 micromhos/mile) when tested in accordance with ASTM D 4566-90 at a frequency of 1.0  $\pm 0.1$  kHz and a temperature of 23  $\pm 3$  °C.

(2) *Pair-to-pair capacitance unbalance*. The capacitance unbalance between any pair of the completed wire must not exceed 145 picofarad/kilometer (pF/km) (80 picofarad/1000 ft (pF/1000 ft)) when tested in accordance with ASTM D 4566-90 at a frequency of 1.0  $\pm 0.1$  kHz and a temperature of 23  $\pm 3$  °C.

(3) *Pair-to-ground capacitance unbalance*—(i) *Pair-to-ground*. The capacitance unbalance as measured on the individual pairs of the completed wire must not exceed 2625 pF/km (800 pF/1000 ft) when tested in accordance with ASTM D 4566-90 at a frequency of 1.0  $\pm 0.1$  kHz and a temperature of 23  $\pm 3$  °C.

(ii) When measuring pair-to-ground capacitance unbalance, all pairs, except the pair under test, are grounded to the shield.

(iii) Pair-to-ground capacitance unbalance may vary directly with the length of the wire.

(4) *Far-end crosstalk loss*. (i) The output-to-output far-end crosstalk loss (FEXT) between any pair combination of a completed wire when measured in accordance with ASTM D 4566-90 at a test frequency of 150 kHz must not be less than 58 decibel/kilometer (dB/km) (63 decibel/1000 ft). If the loss  $K_o$  at a frequency  $F_o$  for length  $L_o$  is known, then  $K_x$  can be determined for any other frequency  $F_x$  or length  $L_x$  by:

$$\text{FEXT loss (K}_X\text{)} = K_O - 20 \log 10 \frac{F_X}{F_O} - 10 \log 10 \frac{L_X}{L_O}$$

(5) *Attenuation.* The attenuation of any individual pair on any reel of wire must not exceed the following limits when measured at or corrected to a temperature of  $20 \pm 1^\circ\text{C}$  and a test frequency of 150 kHz. The test must be conducted in accordance with ASTM D 4566-90.

Conductor AWG	Individual Pair Attenuation dB/km (decibel/mile (dB/mile))	
	Maximum	Minimum
22	6.8 (11.0)	5.0 (8.1)
24	8.7 (14.0)	6.6 (10.7)

(6) *Insulation resistance.* Each insulated conductor in each length of completed wire, when measured with all other insulated conductors and the shield grounded, must have an insulation resistance of not less than 1600 megohm-kilometer (1000 megohm-mile) at  $20 \pm 1^\circ\text{C}$ . The measurement must be made in accordance with the procedures of ASTM D 4566-90.

(7) *High voltage test.* (i) In each length of completed wire, the insulation between conductors when tested in accordance with ASTM D 4566-90 must withstand for 3 seconds a direct current (dc) potential whose value is not less than:

(A) 5.0 kilovolts for 22-gauge conductors; and

(B) 4.0 kilovolts for 24-gauge conductors.

(ii) In each length of completed wire, the dielectric strength between the shield and all conductors in the core must be tested in accordance with ASTM D 4566-90 and must withstand, for 3 seconds, a dc potential whose value is not less than 20 kilovolts.

(8) *Conductor resistance.* The dc resistance of any conductor must be measured in the completed wire in accordance with ASTM D 4566-90 and must not exceed the following values when measured at or corrected to a temperature of  $20 \pm 1^\circ\text{C}$ .

AWG	Maximum Resistance	
	ohms/kilometer	(ohms/1000 ft)
22	57.1	(17.4)
24	90.2	(27.5)

(9) *Resistance unbalance.* (i) The difference in dc resistance between the two conductors of any pair in the completed wire must not exceed 5.0 percent when measured in accordance with the procedures of ASTM D 4566-90.

(ii) The resistance unbalance between tip and ring conductors shall be random with respect to the direction of unbalance. That is, the resistance of the tip conductors shall not be consistently higher with respect to the ring conductors and vice versa.

(n) *Mechanical requirements*—(1) *Defective wire.* Pairs in each length of wire will not be permitted to have either a ground, cross, short or open circuit condition.

(2) *Wire breaking strength.* The breaking strength of the completed wire must not be less than 890 newtons (200 pound-force) when tested in accordance with ASTM D 4565-90a using a jaw separation speed of 25 mm/min (1.0 in./min).

(3) *Wire bending test.* The completed wire must be capable of meeting the requirements of ASTM D 4565-90a after conditioning at  $-20 \pm 2^\circ\text{C}$  and at  $23 \pm 2^\circ\text{C}$ .

(4) *Water penetration test.* (i) A one meter (3 ft) length of completed wire must be stabilized at  $23 \pm 2^\circ\text{C}$  and tested in accordance with ASTM D 4565-90a using a one meter (3 ft) water head over the sample or placed under the equivalent continuous pressure for one hour.

(ii) After the one hour period, there must be no water leakage in the sheath interfaces, under the core wrap or between any insulated conductors in the core.

(iii) If water leakage is detected in the first sample, one 3 m (10 ft) additional adjacent sample from the same reel of wire must be tested in accordance with paragraph (n)(4)(ii) of this section. If the second sample exhibits water leakage, the entire reel of wire is to be rejected. If the second sample exhibits no leakage, the entire reel of wire is considered acceptable.

(5) *Compound flow test.* The completed wire must be capable of meeting the compound flow test specified in ASTM D 4565–90a when exposed for a period of 24 hours at a temperature of  $80 \pm 1$  °C. At the end of this test period, there must be no evidence of flowing or dripping of compound from either the core or sheath interfaces.

(o) *Acceptance testing and extent of testing.* (1) The tests described in appendix A of this section are intended for acceptance of wire designs and major modifications of accepted designs. RUS decides what constitutes a major modification. These tests are intended to show the inherent capability of the manufacturer to produce wire products having long life and stability.

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

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

(ii) Qualification Test Data, per appendix A of this section;

(iii) To periodic plant inspections;

(iv) A certification that the product does or does not comply with the domestic origin manufacturing provisions of the “Buy American” requirements of the Rural Electrification Act of 1938 (7 U.S.C. 901 *et seq.*);

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

(vi) Other nonproprietary data deemed necessary by the Chief, Outside Plant Branch (Telephone).

(3) For requalification acceptance, the manufacturer must submit an original signature certification that the product fully complies with each section of the specification, excluding the Qualification Section, and a certification that the product does or does not comply with the domestic origin manufacturing provisions of the “Buy American” requirements of the Rural Electrification Act of 1938 (7 U.S.C. 901 *et seq.*) for acceptance by June 30 every three years. The required data and certification must have been gathered within 90 days of the submission.

(4) Initial and requalification acceptance requests should be addressed to: Chairman, Technical Standards, Committee “A” (Telephone), Telecommunications Standards Division, Rural Util-

ities Service, Washington, DC 20250–1500.

(5) Tests on 100 percent of completed wire. (i) The shield of each length of wire must be tested for continuity using the procedures of ASTM D 4566–90.

(ii) Dielectric strength between all conductors and the shield must be tested to determine freedom from grounds in accordance with paragraph (m)(7)(ii) of this section.

(iii) Each conductor in the completed wire must be tested for continuity using the procedures of ASTM D 4566–90.

(iv) Dielectric strength between conductors must be tested to ensure freedom from shorts and crosses in accordance with paragraph (m)(7)(i) of this section.

(v) The average mutual capacitance must be measured on all wires.

(6) *Capability tests.* Tests on a quality assurance basis must be made as frequently as is required for each manufacturer to determine and maintain compliance with:

(i) Performance requirements for conductor insulation and jacket material;

(ii) Performance requirements for filling and flooding compounds;

(iii) Sequential marking and lettering;

(iv) Capacitance unbalance and crosstalk;

(v) Insulation resistance;

(vi) Conductor resistance and resistance unbalance;

(vii) Wire bending and wire breaking strength tests;

(viii) Mutual conductance and attenuation; and

(ix) Water penetration and compound flow tests.

(p) *Summary of records of electrical and physical tests.* (1) Each manufacturer must maintain suitable summary of records for a period of at least 3 years for all electrical and physical tests required on completed wire by this section as set forth in paragraphs (o)(5) and (o)(6) of this section. The test data for a particular reel shall be in a form that it may be readily available to the purchaser or to RUS upon request.

(2) Measurements and computed values must be rounded off to the number

of places of figures specified for the requirement according to ASTM E 29-90.

(q) *Manufacturing irregularities.* (1) Repairs to the inner jacket and shield are not permitted in wire supplied to the end user under this section.

(2) Minor defects in the outer jackets (defects having a dimension of 3 mm (0.125 in.) or less in any direction) may be repaired by means of heat fusing in accordance with good commercial practices utilizing sheath grade compound.

(r) *Preparation for shipment.* (1) The wire must be shipped on reels. The diameter of the drum must be large enough to prevent damage to the wire from reeling or unreeling. The reels must be substantial and so constructed as to prevent damage to the wire during shipment and handling.

(2) The thermal wrap must comply with the requirements of appendix C of this section. When a thermal reel wrap is supplied, the wrap must be applied to the reel and must be suitably secured in place to minimize thermal exposure to the wire during storage and shipment. The use of the thermal reel wrap as a means of reel protection will be at the option of the manufacturer unless specified by the end user.

(3) The outer end of the wire must be securely fastened to the reel head so as to prevent the wire from becoming loose in transit. The inner end of the wire must be securely fastened in such a way as to make it readily available if required for electrical testing. Spikes, staples, or other fastening devices which penetrate the wire jacket must not be used. The method of fastening the wire ends must be accepted by RUS prior to it being used.

(4) Each length of wire must be wound on a separate reel unless otherwise specified or agreed to by the purchaser.

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

(6) Each reel must be stenciled or labeled on either one or both sides with the name of the manufacturer, year of manufacture, actual shipping length, an inner and outer end sequential length marking, description of the wire, reel number and the RUS wire designation:

Wire Designation

BFW

Wire Construction

Pair Count

Conductor Gauge

N = Copper Alloy 220 (Bronze) Shield

Y = Gopher Resistant Shields

Example: BFWY 3-24

Buried Filled Wire, Gopher Resistant Shield,  
3 pair, 24 AWG

(7) Both ends of the filled buried wire, manufactured to the requirements of this section, must be equipped with end caps which are acceptable to RUS.

(The information and recordkeeping requirements of this section have been approved by the Office of Management and Budget (OMB) under the control number 0572-0059)

#### APPENDIX A TO § 1755.860—QUALIFICATION TEST METHODS

(I) The test procedures described in this appendix are for qualification of initial designs and major modifications of accepted designs. Included in (V) of this appendix are suggested formats that may be used in submitting test results to RUS.

(II) *Sample Selection and Preparation.* (1) All testing must be performed on lengths removed sequentially from the same 3 pair, 22 gauge jacketed wire. This wire must not have been exposed to temperatures in excess of 38 °C since its initial cool down after sheathing. The lengths specified are minimum lengths and if desirable from a laboratory testing standpoint longer lengths may be used.

(a) Length A shall be 10 ±0.2 meters (33 ±0.5 feet) long and must be maintained at 23 ±3 °C. One length is required.

(b) Length B shall be 12 ±0.2 meters (40 ±0.5 feet) long. Prepare the test sample by removing the inner and outer jacket, shield, and core wrap, if present, for a sufficient distance on both ends to allow the insulated conductors to be flared out. Remove sufficient conductor insulation so that appropriate electrical test connections can be made at both ends. Coil the specimen with a diameter of 15 to 20 times its sheath diameter. Three lengths are required.

(c) Length C shall be one meter (3 feet) long. Four lengths are required.

(d) Length D shall be 300 millimeters (1 foot) long. Four lengths are required.

(e) Length E shall be 600 millimeters (2 feet) long. Four lengths are required.

(f) Length F shall be 3 meters (10 feet) long and must be maintained at 23 ±3 °C for the duration of the test. Two lengths are required.

(2) *Data Reference Temperature.* Unless otherwise specified, all measurements shall be made at 23 ±3 °C.

(III) *Environmental Tests*—(1) *Heat Aging Test*—(a) *Test Samples*. Place one sample each of lengths B, C, D, and E in an oven or environmental chamber. The ends of sample B must exit from the chamber or oven for electrical tests. Securely seal the oven exit holes.

(b) *Sequence of Tests*. After conditioning the samples are to be subjected to the following tests:

- (i) Water Immersion Test outlined in (III)(2) of this appendix;
- (ii) Water Penetration Test outlined in (III)(3) of this appendix; .
- (iii) Insulation Compression Test outlined in (III)(4) of this appendix; and
- (iv) Jacket Slip Strength Test outlined in (III)(5) of this appendix.

(c) *Initial Measurements*. (i) For sample B, measure the open circuit capacitance and conductance for each pair at 1 and 150 kilohertz and the attenuation at 150 kilohertz after conditioning the sample at the data reference temperature for 24 hours. Calculate the average and standard deviation for the data of the 3 pairs on a per kilometer (per mile) basis.

(ii) The attenuation at 150 kilohertz may be calculated from open circuit admittance ( $Y_{oc}$ ) and short circuit impedance ( $Z_{sc}$ ) or may be obtained by direct measurement of attenuation.

(iii) Record on suggested formats attached in (V) of this appendix or on other easily readable formats.

(d) *Heat Conditioning*. (i) Immediately after completing the initial measurements, condition the sample for 14 days at a temperature of  $65 \pm 2^\circ\text{C}$ .

(ii) At the end of this period note any exudation of filling compound. Measure and calculate the parameters given in (III)(1)(c) of this appendix. Record on suggested formats attached in (V) of this appendix or on other easily readable formats.

(iii) Cut away and discard a one meter (3 foot) section from each end of length B.

(e) *Overall Electrical Deviation*. (i) Calculate the percent change in all average parameters between the final parameters after conditioning with the initial parameters in (III)(1)(c) of this appendix.

(ii) The stability of the electrical parameters after completion of this test must be within the following prescribed limits:

(A) *Capacitance*. The average mutual capacitance must be within 5 percent of its original value;

(B) The change in average mutual capacitance must be less than 5 percent over the frequency range of 1 to 150 kilohertz;

(C) *Conductance*. The average mutual conductance must not exceed 2 micromhos/kilometer (3.3 micromhos/mile) at a frequency of 1 kilohertz; and

(D) *Attenuation*. The attenuation must not have increased by more than 5 percent over its original value.

(2) *Water Immersion Electrical Test*—(a) *Test Sample Selection*. The 10 meter (33 foot) section of length B must be tested.

(b) *Test Sample Preparation*. Prepare the sample by removing the inner and outer jacket, shield, and core wrap, if present, for a sufficient distance to allow one end to be accessed for test connections. Cut out a series of 2.5 millimeter by 13 millimeter (0.1 inch by 0.5 inch) rectangular slots along the test sample, at 300 millimeter (1 foot) intervals progressing successively 90 degrees around the circumference of the wire. Assure that the wire core is exposed at each slot by slitting the inner jacket and core wrap if present. Place the prepared sample in a dry vessel which when filled will maintain a one meter (3 foot) head of water over 6 meters (20 feet) of uncoiled wire. Extend and fasten the ends of the wire so they will be above the water line and the pairs are rigidly held for the duration of the test.

(c) *Capacitance and Conductance Testing*. Measure the initial values of mutual capacitance and conductance of all pairs in each wire at a frequency of 1 kilohertz before filling the vessel with water. Be sure the wire shield is grounded to the test equipment. Fill the vessel until there is a one meter (3 foot) head of water on the wires.

(i) Remeasure the mutual capacitance and conductance after the wires have been submerged for 24 hours and again after 30 days.

(ii) Record each sample separately on the suggested formats attached in (V) of this appendix or on other easily readable formats.

(d) *Overall Electrical Deviation*. (i) Calculate the percent change in all average parameters between the final parameters after conditioning with the initial parameters in (III)(2)(c) of this appendix.

(ii) The stability of the electrical parameters after of the test must be within the following prescribed limits:

(A) *Capacitance*. The average mutual capacitance must be within 5 percent of its original value; and

(B) *Conductance*. The average mutual conductance must not exceed 2 micromhos/kilometer (3.3 micromhos/mile) at a frequency of 1 kilohertz.

(3) *Water Penetration Testing*. (a) A watertight closure must be placed over the jacket of length C. The closure must not be placed over the jacket so tightly that the flow of water through preexisting voids or air spaces is restricted. The other end of the sample must remain open.

(b) Test per Option A or Option B. (i) *Option A*. Weigh the sample and closure prior to testing. Fill the closure with water and place under a continuous pressure of  $10 \pm 0.7$  kilopascals ( $1.5 \pm 0.1$  pounds per square inch

gauge) for one hour. Collect the water leakage from the end of the test sample during the test and weigh to the nearest 0.1 gram. Immediately after the one hour test, seal the ends of the wire with a thin layer of grease and remove all visible water from the closure, being careful not to remove water that penetrated into the core during the test. Re-weigh the sample and determine the weight of water that penetrated into the core. The weight of water that penetrated into the core must not exceed 1 gram.

(ii) *Option B.* Fill the closure with a 0.2 gram sodium fluorescein per liter water solution and apply a continuous pressure of  $10 \pm 0.7$  kilopascals ( $1.5 \pm 0.1$  pounds per square inch gauge) for one hour. Catch and weigh any water that leaks from the end of the wire during the one hour period. If no water leaks from the sample, carefully remove the water from the closure. Then carefully remove the outer jacket, shield, inner jacket and core wrap, if present, one at a time, examining with an ultraviolet light source for water penetration. After removal of the inner jacket and core wrap, if present, carefully dissect the core and examine for water penetration within the core. Where water penetration is observed, measure the penetration distance. The distance of water penetration into the core must not exceed 127 millimeters (5.0 inches).

(4) *Insulation Compression Test.* (a) *Test Sample D.* Remove inner and outer jacket, shield, and core wrap, if present, being careful not to damage the conductor insulation. Remove one pair from the core and carefully separate, wipe off core filler and straighten the insulated conductors. Retwist the two insulated conductors together under sufficient tension to form 10 evenly spaced 360 degree twists in a length of 100 millimeters (4 inches).

(b) *Sample Testing.* Center the mid 50 millimeters (2 inches) of the twisted pair between two smooth rigid parallel metal plates measuring 50 millimeters (2 inches) in length or diameter. Apply a 1.5 volt direct current potential between the conductors, using a light or buzzer to indicate electrical contact between the conductors. Apply a constant load of 67 newtons (15 pound-force) on the sample for one minute and monitor for evidence of contact between the conductors. Record results on suggested formats attached in (V) of this appendix or on other easily readable formats.

(5) *Jacket Slip Strength Test*—(a) *Sample Selection.* Test sample E from (III)(1)(a) of this appendix.

(b) *Sample Preparation.* Prepare test sample in accordance with the procedures specified in ASTM D 4565-90a.

(c) *Sample Conditioning and Testing.* Remove the sample from the tensile tester prior to testing and condition for one hour at  $50 \pm 2$  °C. Test immediately in accordance with the

procedure specified in ASTM D 4565-90a. A minimum outer jacket slip strength of 67 newtons (15 pound-force) is required. Record the load attained.

(6) *Humidity Exposure.* (a) Repeat steps (III)(1)(a) through (III)(1)(c)(iii) of this appendix for separate set of samples B, C, D and E which have not been subjected to prior environmental conditioning.

(b) Immediately after completing the measurements, expose the test sample to 100 temperature cyclings. Relative humidity within the chamber must be maintained at  $90 \pm 2$  percent. One cycle consists of beginning at a stabilized chamber and test sample temperature of  $52 \pm 1$  °C, increasing the temperature to  $57 \pm 1$  °C, allowing the chamber and test samples to stabilize at this level, then dropping the temperature back to  $52 \pm 1$  °C.

(c) Repeat steps (III)(1)(d)(ii) through (III)(5)(c) of this appendix.

(7) *Temperature Cycling.* (a) Repeat steps (III)(1)(a) through (III)(1)(c)(iii) of this appendix for separate set of samples B, C, D and E which have not been subjected to prior environmental conditioning.

(b) Immediately after completing the measurements, subject the test sample to 10 cycles of temperature between  $-40$  °C and  $+60$  °C. The test sample must be held at each temperature extreme for a minimum of  $1\frac{1}{2}$  hours during each cycle of temperature. The air within the temperature cycling chamber must be circulated throughout the duration of the cycling.

(c) Repeat steps (III)(1)(d)(ii) through (III)(5)(c) of this appendix.

(IV) *Control Sample*—(1) *Test Samples.* A separate set of lengths for samples A, C, D, and E must have been maintained at  $23 \pm 3$  °C for at least 48 hours before the testing.

(2) Repeat steps (III)(2) through (III)(5)(c) of this appendix except use length A instead of length B.

(3) *Surge Test.* (a) One length of sample F must be used to measure the breakdown between conductors while the other length of F must be used to measure core to shield breakdown.

(b) The samples must be capable of withstanding, without damage, a single surge voltage of 20 kilovolts peak between conductors, and 35 kilovolts peak between conductors and the shield as hereinafter described. The surge voltage must be developed from a capacitor discharge through a forming resistor connected in parallel with the dielectric of the test sample. The surge generator constants must be such as to produce a surge of  $1.5 \times 40$  microseconds wave shape.

(c) The shape of the generated wave must be determined at a reduced voltage by connecting an oscilloscope across the forming resistor with the wire sample connected in parallel with the forming resistor. The capacitor bank is charged to the test voltage

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and then discharged through the forming resistor and test sample. The test sample will be considered to have passed the test if there is no distinct change in the wave shape obtained with the initial reduced voltage com-

pared to that obtained after the application of the test voltage.

(V) The following suggested formats may be used in submitting the test results to RUS:

ENVIRONMENTAL CONDITIONING \_\_\_\_\_

FREQUENCY 1 KILOHERTZ

PAIR NUMBER	CAPACITANCE		CONDUCTANCE	
	nF/km	(nF/mile)	micromhos/km	(micromhos/mile)
	Initial	Final	Initial	Final
1	_____	_____	_____	_____
2	_____	_____	_____	_____
3	_____	_____	_____	_____
Average $\bar{x}$	_____	_____	_____	_____
Overall Percent Difference in Average $\bar{x}$			Capacitance: _____	
Conductance: _____				

ENVIRONMENTAL CONDITIONING \_\_\_\_\_

FREQUENCY 150 KILOHERTZ

PAIR NUM- BER	CAPACITANCE		CONDUCTANCE		ATTENUATION	
	nF/km	(nF/mile)	micromhos/ km	(micromhos/ mile)	dB/km	(dB/mile)
	Initial	Final	Initial	Final	Initial	Final
1	_____	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____	_____
Average $\bar{x}$	_____	_____	_____	_____	_____	_____
Overall	Percent	Difference	in Average $\bar{x}$		Capacitance: _____	
			Attenuation: _____		Conductance: _____	

ENVIRONMENTAL CONDITIONING \_\_\_\_\_

WATER IMMERSION TEST (1 KILOHERTZ)

PAIR NUMBER	CAPACITANCE			CONDUCTANCE		
	nF/km	(nF/mile)		micromhos/km	(micromhos/mile)	
	Initial	24 hours	Final	Initial	24 hours	Final
1	_____	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____	_____
Average $\bar{x}$	_____	_____	_____	_____	_____	_____
Overall Percent Difference in Average $\bar{x}$			Capacitance: _____			
Conductance: _____						

WATER PENETRATION TEST

	Option A		Option B	
	End Leakage grams	Weight Gain grams	End Leakage grams	Penetration mm (in.)
Control .....	_____	_____	_____	_____
Heat Age .....	_____	_____	_____	_____
Humidity Exposure	_____	_____	_____	_____

## WATER PENETRATION TEST—Continued

	Option A		Option B	
	End Leakage grams	Weight Gain grams	End Leakage grams	Penetration mm (in.)
Temperature Cycling.	_____	_____	_____	_____

## INSULATION COMPRESSION

Failures	
Control .....	_____
Heat Age .....	_____
Humidity Exposure .....	_____
Temperature Cycling .....	_____

## JACKET SLIP STRENGTH @ 50 °C

Load in newtons (pound-force)	
Control .....	_____
Heat Age .....	_____
Humidity Exposure .....	_____
Temperature Cycling .....	_____

## FILLER EXUDATION (GRAMS)

Heat Age .....	_____
Humidity Exposure .....	_____
Temperature Cycle .....	_____

## SURGE TEST (KILOVOLTS)

Conductor to Conductor .....	_____
Shield to Conductors .....	_____

## APPENDIX B TO § 1755.860—SHEATH SLITTING CORD QUALIFICATION

(I) The test procedures described in this appendix are for qualification of initial and subsequent changes in sheath slitting cords.

(II) *Sample Selection.* All testing must be performed on two 1.2 meters (4 feet) lengths of wire removed sequentially from the same 3 pair, 22 gauge jacketed wire. This wire must not have been exposed to temperatures in excess of 38 °C since its initial cool down after sheathing.

(III) *Test Procedure.* (1) Using a suitable tool, expose enough of sheath slitting cord to permit grasping with needle nose pliers.

(2) The prepared test specimens must be maintained at a temperature of 23 ±1 °C for at least 4 hours immediately prior to and during the test.

(3) Wrap the sheath slitting cord around the plier jaws to ensure a good grip.

(4) Grasp and hold the wire in a convenient position while gently and firmly pulling the sheath slitting cord longitudinally in the direction away from the wire end. The angle of pull may vary to any convenient and functional degree. A small starting notch is permissible.

(5) The sheath slitting cord is considered acceptable if the cord can slit the jacket and/or shield for a continuous length of 0.6 meter (2 feet) without breaking the cord.

## APPENDIX C TO § 1755.860—THERMAL REEL WRAP QUALIFICATION

(I) The test procedures described in this appendix are for qualification of initial and subsequent changes in thermal reel wraps.

(II) *Sample Selection.* All testing must be performed on two 450 millimeter (18 inch) lengths of wire removed sequentially from the same 3 pair, 22 gauge jacketed wire. This wire must not have been exposed to temperatures in excess of 38 °C since its initial cool down after sheathing.

(III) *Test Procedure.* (1) Place the two samples on an insulating material such as wood, etc.

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

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

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

(5) The height of the lamp above the jacket shall be 380 millimeters (15 inches) or a height that produces the 71 °C jacket temperature on the unwrapped sample.

(6) 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.

(7) Compute the temperature difference between the jackets.

(8) For the thermal reel wrap to be acceptable to RUS, the temperature differences between the jacket with the thermal reel wrap



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and the jacket without the reel wrap must be greater than or equal to 17 °C.

[58 FR 61004, Nov. 19, 1993, as amended at 60 FR 1711, Jan. 5, 1995; 69 FR 18803, Apr. 9, 2004]

## §§ 1755.861–1755.869 [Reserved]

### § 1755.870 RUS specification for terminating cables.

(a) *Scope.* (1) This section establishes the requirements for terminating cables used to connect incoming outside plant cables to the vertical side of the main distributing frame in a telephone central office.

(i) The conductors are solid tinned copper, individually insulated with extruded solid dual insulating compounds.

(ii) The insulated conductors are twisted into pairs which are then stranded or oscillated to form a cylindrical core.

(iii) The cable structure is completed by the application of a core wrap, a shield, and a polyvinyl chloride jacket.

(2) The number of pairs and gauge size of conductors which are used within the RUS program are provided in the following table:

American Wire Gauge (AWG)	22	24
Number of Pairs .....	12	12
	50	50
	100	100
	200	200
	300	300
	400	400
	600	600
	800	800

NOTE: Cables larger in pair sizes from those shown in this table shall meet all the requirements of this section.

(3) All cables sold to RUS borrowers for projects involving RUS loan funds under this section must be accepted by RUS Technical Standards Committee “A” (Telephone). For cables manufactured to the specification of this section, all design changes to an accepted design must be submitted for acceptance. RUS will be the sole authority on what constitutes a design change.

(4) Materials, manufacturing techniques, or cable designs not specifically addressed by this section may be allowed if accepted by RUS. Justification for acceptance of modified materials, manufacturing techniques, or cable designs shall be provided to substantiate product utility and long term stability and endurance.

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(5) The American National Standard Institute/Electronic Industries Association (ANSI/EIA) 359–A–84, EIA Standard Colors for Color Identification and Coding, referenced in this section is incorporated by reference by RUS. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of ANSI/EIA 359–A–84 are available for inspection during normal business hours at RUS, room 2845, U.S. Department of Agriculture, Washington, DC 20250–1500, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html). Copies are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, telephone number (303) 792–2181.

(6) American Society for Testing and Materials Specifications (ASTM) B 33–91, Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes; ASTM B 736–92a Standard Specification for Aluminum, Aluminum Alloy and Aluminum-Clad Steel Cable Shielding Stock; ASTM D 1248–84 (1989), Standard Specification for Polyethylene Plastics Molding and Extrusion Materials; ASTM D 1535–89, Standard Test Method for Specifying Color by the Munsell System; ASTM D 2287–81 (Reapproved 1988), Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds; ASTM D 2436–85, Standard Specification for Forced-Convection Laboratory Ovens for Electrical Insulation; ASTM D 2633–82 (Reapproved 1989), Standard Methods of Testing Thermoplastic Insulations and Jackets for Wire and Cable; ASTM D 4101–82 (1988), Standard Specification for Propylene Plastic Injection and Extrusion Materials; ASTM D 4565–90a, Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable; ASTM D 4566–90, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable;